A SHORT GUIDE TO FISH PRESERVATION

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

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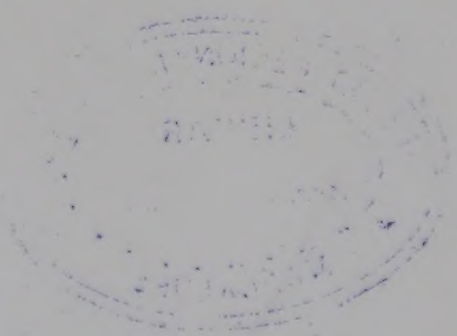

Cover photo: *Selling smoked fish in the central market of Accra.*

A SHORT GUIDE TO FISH PRESERVATION

with special reference to West African conditions

by

G. C. RAWSON, B. SC.

With a chapter by

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Thanks are due to M. J. Cadanat for permission to reproduce the drawings of West African fish from his book *Poissons de mer du Sénégal*, published by l'Institut français d'Afrique noire, Dakar, 1950. Thanks are also due to Dr. Arno Meschkat, Regional Fisheries Officer for Africa, for the loan of some photographs.

INTRODUCTION

Fish is a highly perishable commodity — far more so than cattle, sheep and poultry, for example. Some time usually elapses before it is consumed, except in the immediate neighborhood of fishing ports. It is therefore necessary to preserve it if it is to reach the consumer in good condition.

The object of this manual is to describe ways of handling and preserving fish caught off the West African coast by simple and economic methods, utilizing locally available materials. The methods are those used in West Africa: other regions of Africa adopt variations of these methods.

Fish may be preserved in many ways; it may be salted, smoked, dried, iced, frozen, canned or turned into fish powder. As the first three are the easiest and cheapest processes, this manual is primarily concerned with them. The other methods are referred to briefly in an appendix, together with suggestions for further reading.

The preservation processes described in relation to sea fish are equally applicable to the preservation of freshwater fish.

It is unfortunate that in the tropics, where animal protein is so badly needed in the diets of the people, climatic conditions are such that spoilage of fish is much more likely to occur. Fish may start to deteriorate in a few hours, so any quick and simple steps to preserve a catch are beneficial. In contrast, fish can be held for a day or two in temperate climates, while in the Arctic it rapidly becomes frozen.

Wider understanding of the present methods of handling and their possible improvement (either on a simple or more elaborate scale) is therefore highly desirable.

It has been observed in at least one West African country that

production, limited by smoking capacity and the market organization of the traders, has risen by many thousands of tons following increased facilities for handling fish by the construction of large central cold stores at the fishing harbor.

Fish will spoil fairly rapidly after being caught unless steps are taken to arrest the process. Bacteria, one of the main causes of spoilage, are extremely small organisms which multiply rapidly in certain conditions and if they have a suitable source of food. Some types of bacteria prefer to feed on dead animal or plant life: it is these which cause spoilage of fish. Chemical reactions (enzyme action) resulting from the feeding process also lead to spoilage, and as the bacteria multiply, so the process accelerates. It follows that if the numbers of bacteria can be limited then spoilage will be retarded. Some knowledge of the conditions suitable for bacterial growth will help therefore to achieve good preservation.

Although the proportions may vary somewhat with different species, in general we may say that fish are made up of:

Water	Protein	Fat	Ash
	Percent		
70	20	5	5

Water is essential to bacteria. Fish have a high percentage of water, so that bacterial activity is minimized if this is reduced. Less than 3 percent water brings bacterial activity to a standstill; between 4 percent and 25 percent conditions are ideal.

Temperature is also an important factor because most bacterial activity ceases at either very high or very low temperatures. Thus preservation may be achieved either by the application of heat or cooling and freezing processes. Application of heat will stop bacterial action and the removal of water — by salting, smoking or drying — prevents its resumption.

1. THE NUTRITIONAL IMPORTANCE OF FISH IN WEST AFRICAN DIETS

by Florence A. Sai

Fish is a very important item in West African diets. The reasons for this are many and varied. The main one, however, is that fish contains large quantities of protein, a nutrient essential for health and growth of the body. Protein is present in many foods both of animal and vegetable origin, but the best protein is that which comes from animal products. It is for this reason that meat, poultry, eggs, milk, fish, snails and insects are important to supplement diets rich in vegetable protein such as beans and groundnuts. But meat on the whole is expensive and cannot be bought by the man in the street in appreciable quantities. Supplies of game fluctuate, and are expensive. Snails, edible insects and grubs can supply only a small part of the animal protein needed for a steady rate of growth and repair of body tissue.

Poultry is available all over the region: it is cheap in most northern parts of West African countries, but in these areas various taboos and beliefs prevent the general consumption of both poultry and eggs. In the big cities and urban areas, on the other hand, poultry is rather expensive.

Fish, therefore, is a particularly important source of animal protein in many parts of West Africa. There is little or no religious rejection of it, which gives it an advantage over pork or beef, and luckily consumers have already developed a taste for preserved fish. It is also worth noting that the present cost of a pound of fish is approximately half that of beef, pork or mutton.

Since fish can be obtained only from the sea, rivers, streams, lagoons, lakes and ponds, the areas of supply are limited. In order to supply areas distant from the sources, the fish trade is dependent on transportation. Under the best circumstances it may take days, and even weeks, to move fish from the source to markets.

FIGURE 1. – *Packing portions of dried fish.*

This emphasizes the importance of preservation methods. Fish, being very perishable, must be preserved in the best possible way to make it available in a fresh state to consumers living long distances away.

People can distinguish between well preserved and badly preserved fish, and this makes it essential to spread a knowledge of economical and practicable methods of preservation for use during periods when catches are plentiful.

Value of fish in the diet

Fish is required by adults in health (and more so in illness), during pregnancy and lactation. It is especially valuable for growing and sick children.

The disease kwashiorkor which occurs in many areas of West Africa and causes much illness and many thousands of deaths each year is due mainly to lack of protein in the diet of children. Kwash-

iorkor occurs most commonly in young children, who, after they have stopped receiving adequate breast milk, are given a diet consisting mainly of starchy foods such as rice, cassava, yams, plantains, etc. Children with kwashiorkor fail to grow properly, they become miserable, their hair may change in color and texture and their feet and other parts of the body swell up. If untreated they may die, after developing diarrhea and often a skin rash. But apart from the children with this serious disease, there are many others who, although not obviously ill, are smaller than they should be for their age. They are prone to ailments such as diarrhea, are weak and may have anemia because of their diet. All these conditions can be prevented by supplying adequate protein as part of a well-balanced diet.

The eating of fish can prevent kwashiorkor and help West African children to grow normally and happily into adolescence. When fish is available to a family a fair share should be eaten by the toddlers and younger children. This principle applies also to other protein-rich foods such as milk, meat, eggs, beans, groundnuts and so on.

1 oz (28 g) of fish provides the body with:

Type of fish	Calories	Protein	Fat
White fish (fresh)	28	5.0	0.9
Oily fish (fresh)	48	5.7	2.8
White fish (smoked)	90	20.0	1.1
Oily fish (smoked)	105	20.0	5.0

The delicate flavor and lightness of white fish make it especially attractive for children and in the sickroom. It is true that fatty fish has a strong flavor but this fish contains essential health-giving vitamins A and D stored in the oil, as well as an appreciable amount of thiamin, riboflavin and nicotinic acid (B group vitamins which are deficient in many West African diets).

Fat is the other major nutrient supplied by oily fish. This is a ready source of energy which is valuable in areas where the overall calorie intake per head is insufficient.

Small fish are particularly useful in West Africa, where milk is scarce except in the small isolated cattle-growing areas, because they are generally used whole — bones, skin and all. Each ounce of fish provides 600 mg of calcium, which is needed for healthy bones and teeth. Calcium is essential for growing children and for women during pregnancy and lactation.

In addition to these major nutrients fish contributes trace elements such as phosphorus, iron, magnesium, and copper to the diet.

TABLE OF QUANTITIES PER 100 GRAMS (approximately 3½ oz)

Type of fish	Calcium	Iron	Vitamin A	Thiamine	Riboflavin	Nicotinic acid
	..... *mg*		... *I.U.* ...	..... *mg*		
White fish (fresh) .	210	1.0	0.0	0.05	0.04	1.0
Oily fish (fresh) . .	11.0	0.3	30.0	0.02	0.06	0.8
White fish (smoked)	120.0	1.1		0.05	0.17	2.2
Oily fish (smoked) .	240.0	1.1		0.02	0.09	1.0

Fish contains a lot of water so that the nutrients must be calculated after some of the moisture has been extracted. This makes fish preserved in a dry state comparatively more valuable than that preserved in a medium of water. For example, a given weight of fish meal or fish powder is richer in nutrients than an equal weight of frozen fish.

Fish, fresh or preserved, used in dishes

Steaks of fresh fish or small whole fresh fish are used to prepare delicious soups and stews in West Africa. Fresh fish is also fried and served with tomato and onion gravy or with pepper sauce. Sometimes the fish is grilled instead of fried and served in the same way.

Although salted and smoked fish can be used in similar ways to fresh fish, they must be prepared with more care. Less salt than usual will be needed for dishes prepared with salted fish.

Smoked fish

As indicated in chapter 5, this is the oldest method of preserving fish in West Africa. It is therefore natural that smoked fish should be better established in local diets.

In the past when ice was not available and roads were very bad, fresh fish was marketed only along the coast or around the fishing ports, whereas smoked fish went to many parts of the country.

Smoked fish is added to any meat or game which might be available to make light or plain soup, and is used alone or with other animal protein to make thicker soups like palmnut soup, groundnut, agushi or green-leaf soup. A little of it is used to improve the flavor of green-leaf and other vegetable stews. Now, with improved transportation, more fish can be marketed at a distance from the fishing ports, and it has become an item of diet in its own right, not merely a flavoring agent.

Smoked fish with its distinctive flavor and rich nutritive value makes foods like agushi stew, palava sauce, garden egg or bean stew both tasty and nutritious. Smoked fish supplemented by dried snails, shrimps or other shell fish, or dawadawa, adds nutriment and flavor to such dishes as groundnut soup, palmnut soup and pepper soup.

Dishes with fish meal or fish powder[1]

Fish meal or powder may be stored by every housewife on the kitchen shelf for three reasons:

(*a*) to increase the quantity of body-building protein in each meal;

(*b*) to provide protein in an ideal form for the toddler and the young child - i.e., fish with no bones and no skin, which requires little or no chewing, is suitable for including in soft weaning foods, and is quickly cooked;

(*c*) to improve the flavor of insipid dishes.

Fish meal is readily accepted in strong-flavored soups and stews. It adds flavor at little cost to hot pots like mpotompoto (root-vegetable hot pot) and also raises their nutritive value.

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[1] Fish protein-concentrate.

Fish powder with its milder flavor can be included in delicately flavored dishes like mashed spinach (nkotomire, amaranthus or any other edible leaf) or garden eggs with palm oil.

Fish powder or meal in the gravy accompanying stewed beans (aboboi or yoo) or fried bean cakes (akla or muemue) will supplement the vegetable protein and help to make such dishes more nutritious. When eggs are difficult to obtain, fish meal can be used in all savory dishes normally requiring the addition of eggs to improve the value. One ounce (28 g) of fish powder in a serving of soft-boiled rice and margarine provides the body with:

Calories	Protein	Fat	Calcium	Carbohydrates	Iron
	..... g		..... mg	..... g	..... mg .....
329	18.9	10.0	603.25	65.9	2.4

and traces of vitamins (more when the margarine is fortified).

The following are examples of tasty fish meal dishes:

1. One or two teaspoonsful of fish meal stirred into the child's mpotompoto.
2. One tablespoonful of fish meal in the child's helping of egg or soup before adding the accompanying starchy food.
3. A teaspoonful stirred into any thick soup or stew makes a welcome change.
4. Mashed kenky, rice, yam or plantain can be mixed with two teaspoonsful of fish meal before giving to the child.

The approximate values of nutrients in one of the meals above are as follows:

Spinach stew (nkontomle flo) and 1 slice of yam in palm oil provides:

Cals.	Prot.	Fat	Calcium	Carb.	Iron	Thiamine	Riboflavin	Nicotinic Acid
	..... g		mg	g	..... mg			
280	19.6	16.8	652.0	18.2	32.3	0.05	0.04	1.6

Free and generous use of fish meal in all savory dishes for the weanling and toddler will be a great step toward the solution of the kwashiorkor problem.

Salted fish

Salting as a method of curing fish was originally employed during the glut season when " fish mammies " could not get rid of any more of their wares. Consequently, salting was carried out when fish was well on the way to spoiling. An exception to this was where freshwater, lagoon and estuary fish were selected and the best, biggest and fleshiest salted and dried (e.g., didei; Cichlid; *Pelmatochromis guenther* from Keta and Lome). This, coupled with the lengthy process of drying, gave dry salted fish its very pungent and quite often unwholesome smell.

However, both smell and taste have come to be so well known that " momoi " or " stink-fish " has become quite a luxury food to some housewives. Probably many secretly long for the day that they can include this luxury fish in their marketing list without being embarrassed by the questioning glances and head jerkings from their traveling companions on the bus or lorry. They would also like to be able to buy good quantities to store on their kitchen shelf for use when required.

It is to be hoped that this manual will do something to encourage people who are still engaged in this method of preserving fish to promote the taste for dry salted fish without the accompanying unpleasant odor.

Those who fear that the removal of the excess smell will reduce the flavor have only to consider kippers (salted and smoked) or anchovies to realise that this need not be so.

The cost of this fish in the markets all along the coast emphasizes its luxury status. Sections of big or medium-sized white fish, cassava fish (*Pseudo-tolithus*) with or without bones, are sliced after being beaten flat in stamp sizes and sold for 1d, 2d or 3d, depending on the distance between market and place of production. A big salted didei (*P. guenther*) weighing 2—3 lb costs from 6d to 1/6d, again depending on location.

Recipes

Didei is used by itself generally grilled and served with pepper sauce to accompany kenky or banku, or else grilled and then stewed slowly in tomato and onion gravy with a generous helping of pepper. When topped with an egg or two, this tastes delicious with rice or kenky. No matter which method is used to cook this fish, the first step should be thorough washing and soaking for 15—30 minutes in cold water to remove excess salt. When the younger members of the family are eating this dish it should be filleted and the bones removed, although this naturally reduces the calcium content of the diet.

A pennyworth of " stink fish " is used generally for flavoring. Used in such small quantities its dietary value is negligible, but when used with other fish, usually smoked, dry shrimps, and melluse, the combination has an entirely different flavor — enough to make the driest mouth water. The most valuable use of this fish therefore lies in its capacity of making other foods more readily acceptable. A good example of this is to note how quickly a bowl full of boiled mashed cocoyam or potato leaves with half a cup of palm oil poured over and served with boiled roots will be eaten if it has some " stink fish " mashed in with it. A meal of this nature can easily be balanced in terms of nutrients by stirring in a tablespoonful of fish meal. It is an easy and cheap meal for the toddler and under-fives in any family.

Canned fish

Why is canned fish a luxury food at present in most markets in West Africa? Because most of the canned fish available to the consumer is imported and generally has quite a high tax imposed. Thus, sardines, pilchards, herrings in oil or tomato sauce and tuna in brine are all fairly expensive; salmon, shrimp, lobster and crab are even more costly. Not all of these products are found in West African waters, but the organized development of canneries to deal with those that are available would be most desirable, because canned fish is a very popular food in all urban groups and in many rural areas too.

Recipes

Sardines are a popular breakfast food with hot pepper sauce and kenky. They are also good served in tomato and onion gravy with egg as a quick lunch or supper dish to accompany rice, yam, kenky or bread. Pilchards and herrings are often used in quick soups and stews, usually cooked with a generous seasoning of pepper.

Tuna and salmon in soups and stews are popular in towns, cities and villages with those who can afford them. Likewise tuna, salmon, lobster, shrimps and crab are found in mixed vegetable salads for festive occasions, such as christenings, weddings, anniversaries, etc.

The market is therefore assured for anybody who takes up the challenge and goes in for fish canning in a big way, provided the extensive capital required is available, and a program can be well organized to can different fish at the height of its glut season so as to reduce retail prices as much as possible.

When fresh fish is not available in any particular area it is invariably due to lack of transportation. Preservation is the answer to this problem. But preservation is only possible during a short period of time, so that in the interests of both producer and consumer fish should be " saved " as soon as possible after catching and afterwards preserved in the best possible way.

Many recipes exist for using fish preserved by the methods described in this book. Most of these are acceptable to all sections of the West African community.

2. TYPES OF FISH CAUGHT ON THE WEST AFRICAN COAST: THEIR RESPECTIVE PRESERVATION QUALITIES

Main fish groups by their range of locality

Fish, widespread over the oceans of the world, may be broadly divided into two main groups. Those that swim near to the surface are called pelagic; those that swim close to the bottom are known as demersal. Pelagic fish often congregate in dense masses known as shoals; among them are the herrings, tunas, mackerels, pilchards and related species. The bottom feeders are more solitary in their habits but may occur in fairly large numbers on a particular feeding ground. Demersal fish tend to be less oily than pelagic fish and their availability depends a great deal on the type of sea bottom, the depth of the sea bed and whether fishing can be carried out at that

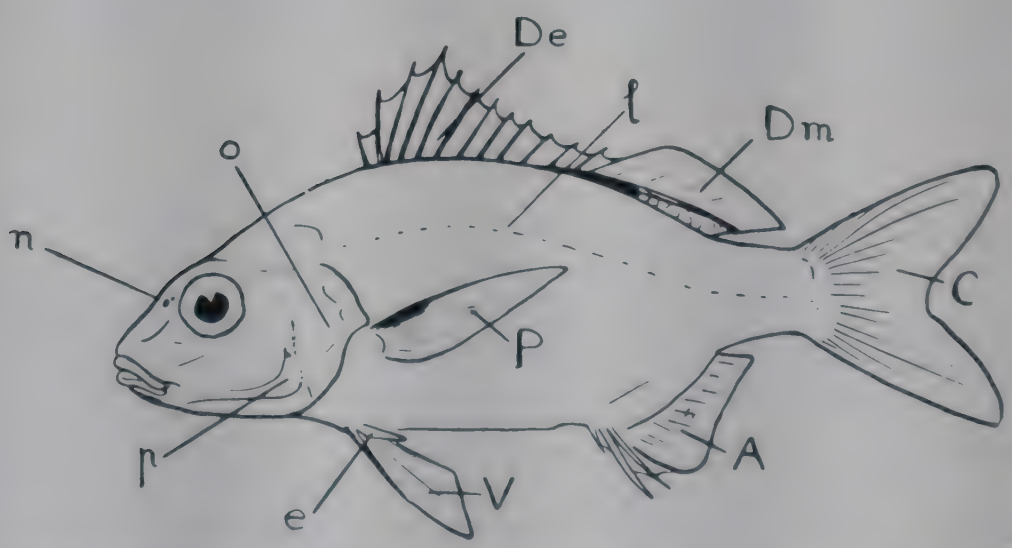


FIGURE 2. – Pristipoma. **n**: *nostril.* **p**: *pre operculum.* **o**: *operculum.* **e**: *spine on pelvic fin.* **P**: *pectoral fin.* **V**: *pelvic fin.* **A**: *anal fin.* **C**: *caudal fin.* **Dm**: *soft dorsal fin.* **De**: *spiny dorsal fin.* **l**: *lateral line.*

point. It is not known whether fish live in the deepest water of the oceans, and most bottom fishing is confined to a belt around the sea coasts known as the Continental Shelf, which may vary in width from a few to several hundred miles.

Some of the common fish species

Cartilaginous fish or selachians

These are fish with skeletons, consisting not of bone but cartilaginous material: this group comprises sharks, dogfish, rays and guitarfishes.

These fish are distinguished by an absence of scales which are replaced in certain species by small protuberances called dermal denticles. These denticles impart to the skin a rough surface which can be utilized for polishing purposes if the skin is preserved (shagreen).

Most sharks have a large curved tail and the shape is easily recognized.

Unlike the bony fishes selachians have a single gill cover for each of the five gill arches.

A characteristic of the selachians is that they emit a strong smell of ammonia when left unpreserved for some time. This is because their flesh is rich in nitrogenous substances which are given off shortly after death.

Most of the shark family can be preserved by smoking and a good product obtained.

Batoidei

Guitarfish or sand shark. This is common throughout West Africa and grows to 200 lb or more. Rather coarse flesh when taken large: easily obtained and produces a good smoked product.

Sawfish. Rather like a guitarfish but with characteristic elongated mouth for either attack or defense. It is good food and can be well preserved by smoking.

Torpedo ray. Not popular as a food in certain parts of West Africa.

Manta ray. Grows to a large size: eyes on side of horns. Is not caught in large quantities and its preservation qualities are not fully known.

Stingray. The tail has a serrated spine which can inflict painful injuries as it is lashed about. Caught in trawl nets or set nets, this fish is good to eat and can be well preserved by smoking. It will keep for several weeks if sufficiently cured.

Thornback ray. Similar to the stingray as food and for keeping qualities when smoked.

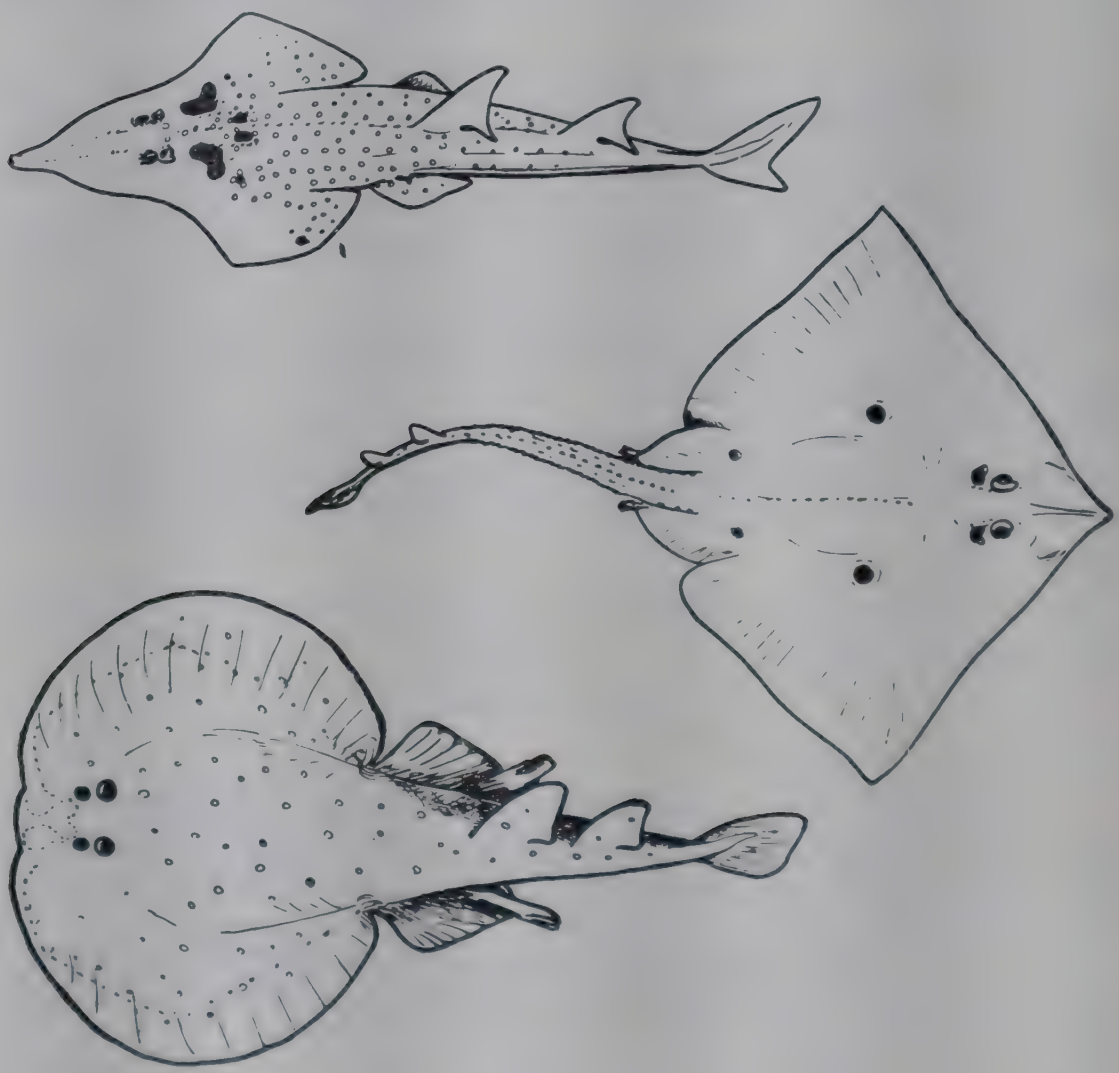


FIGURE 3. – *Three examples of the ray family which are closely related to sharks.* Top: *the guitarfish or sandshark.* Center: *thornback ray.* *Bottom*: electric ray.

Teleostei or bony fish

Elopidae

Tarpon. This fish often reaches 150 lb (68 kg) in weight and is caught on lines or in beach seine nets. The flesh in large fish is coarse and rather tough when smoked.

Ethmalosa

Shad. This species is the most widely caught fish in Sierra Leone. It is caught throughout the year in large quantities and when smoked provides a very good product for sale inland. It is also found in good quantities off Nigeria and parts of Guinea.

Carangidae

Carangidae or horse mackerel are dark fleshed in texture but rather more strongly flavored than the Scombridae. They are very popular when smoked and have been canned and dried experimentally in Keta in Ghana. They once provided important fishing in this area but this has declined in recent years. Distribution is as for Scombroidae as they tend to abound where their food, such as *Sardinella* and anchovy, are to be found. When exported they are deep-frozen and must be thawed before processing, so that if well frozen this fish can be processed after several weeks of storage.

Experiments have shown that this family can be converted to a very fine fish powder by a similar process to that for *Sardinella* described in a later chapter.

Scombridae

Mackerels, tunas and fish like the herring are widely distributed in tropical seas. Tunas in particular are important as they can be canned successfully, and where caught in quantity are of great economic importance. Tuna caught off Sierra Leone, Ivory Coast and Ghana is already being exported for canning in Puerto Rico. All species can be smoked for local use and are popular.

Typical scombroid or tuna fish. This is one of the most powerful swimmers and tuna can often be found in very dense shoals. Tuna fish are found off the West African coast and are caught either on hand lines or long lines or in purse seine nets.

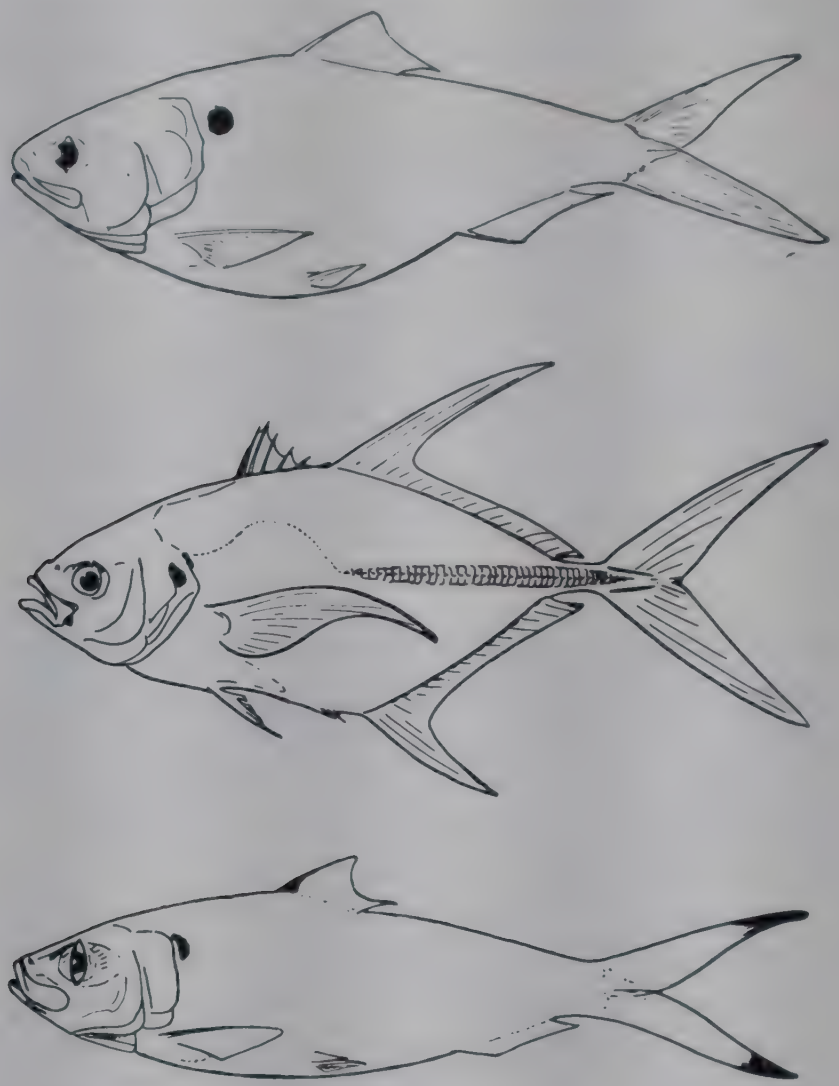


FIGURE 4. – Top: *The shad, a small fish to be found in or near to esturine waters in Sierra Leone, parts of Ghana and Nigeria.* Center: *horse mackerel. There are many species of this fish to be found in the tropics. It is popular as a food, is strongly flavored and makes a good smoked product.* Bottom: *Sardinella eba. Found in shoals off the coast of West Africa. This fish is often smoked.*

FIGURE 4 (CONTINUED). – *Tuna fish. An oily fish of very firm flesh, ideal for canning.*

Some of the common trawl or purse-seine caught fish

Clupeidae

The Clupeidae are widely distributed through West Africa and are caught in large quantities. In Nigeria and Sierra Leone Ethmalosa with some *Engraulis* and *Sardinella* are to be found also. Sierra Leone, Togo and Ivory Coast have dense shoals of *Sardinella aurita* during certain seasons. For Ghana and Togo the good season is during the rains, from July to September, and in the Ivory Coast from November to February. Most of the fish are smoked but *Engraulis* is often dried, and " herring " has been experimentally canned in Ghana.

Saluridae

Arius sp. or sea catfish are caught in either trawl or set nets along much of the West African coast. The flesh is rather oily in texture and results in an excellent product when smoked. The flesh tends not to dry up as readily as that of other white fish.

Polynemidae

These fish are found throughout the West Coast of Africa and are characterized by the threadlike appendages below the pectoral fin.

An additional feature well-known among fishermen is the transparent mass of cartilaginous material on the nose. This gives rise to several names such as " glassnose " or " shininose." Caught in trawl or set nets: smokes well.

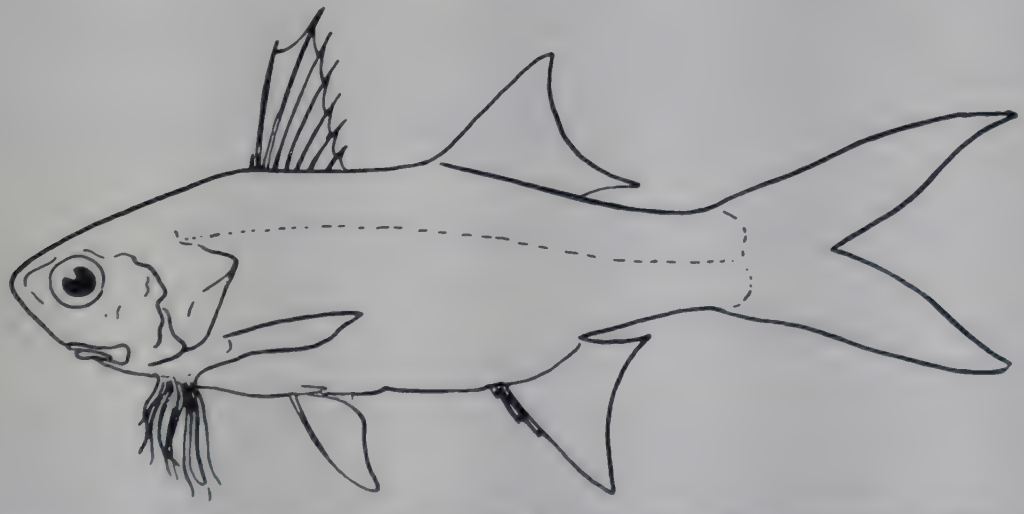


Figure 5. – Galeoides polydactylus. *One of the threadfins, sometimes called the glassnose because of the clear cartilaginous thickening at the end of the nasal region.*

3. CATCHING AND HANDLING: SOME TYPES OF FISHING GEAR AND METHODS OF FISHING

How to judge the condition of fish

Fresh fish have bright eyes, with the center of the pupil black and the remainder transparent. In stale fish the pupils are opaque, even milky. The gills of fresh fish are bright red and free from slime. Stale fish have slime on their gills, which tend to smell and have lost their bright color. In fresh fish the flesh is firm. As spoilage advances the flesh softens progressively, and the color of the blood darkens from deep red to brown.

Probably the most noticeable characteristic of spoiling fish is the smell. This must not, however, be confused with the ammonia smell in sharks and rays.

Whatever methods of catching fish are employed spoilage must be reduced to a minimum before organized preservation is put into operation. To obtain this it is necessary:

1. To improve catching methods to obtain quicker catches in better conditions;
2. To handle fish correctly, in order to maintain the fresh condition as long as possible;
3. To use auxiliary power to increase mobility of fishing boats and reach central markets;
4. To smoke, ice or freeze the product on board ship.

Catching and handling

Because fish are subject to deterioration as soon as they are caught (this does not mean landed in the boat; fish dead in gill nets also spoil quickly) every precaution must be taken to ensure that the greatest degree of protection is given to the fish. The nor-

mal dry season temperature of the sea in the tropics is approximately 28°C or 82°F, which is very warm; so that after a fish is caught it should not remain in the water longer than necessary. Sea water is full of bacteria and death of the fish often results in rapid decom-

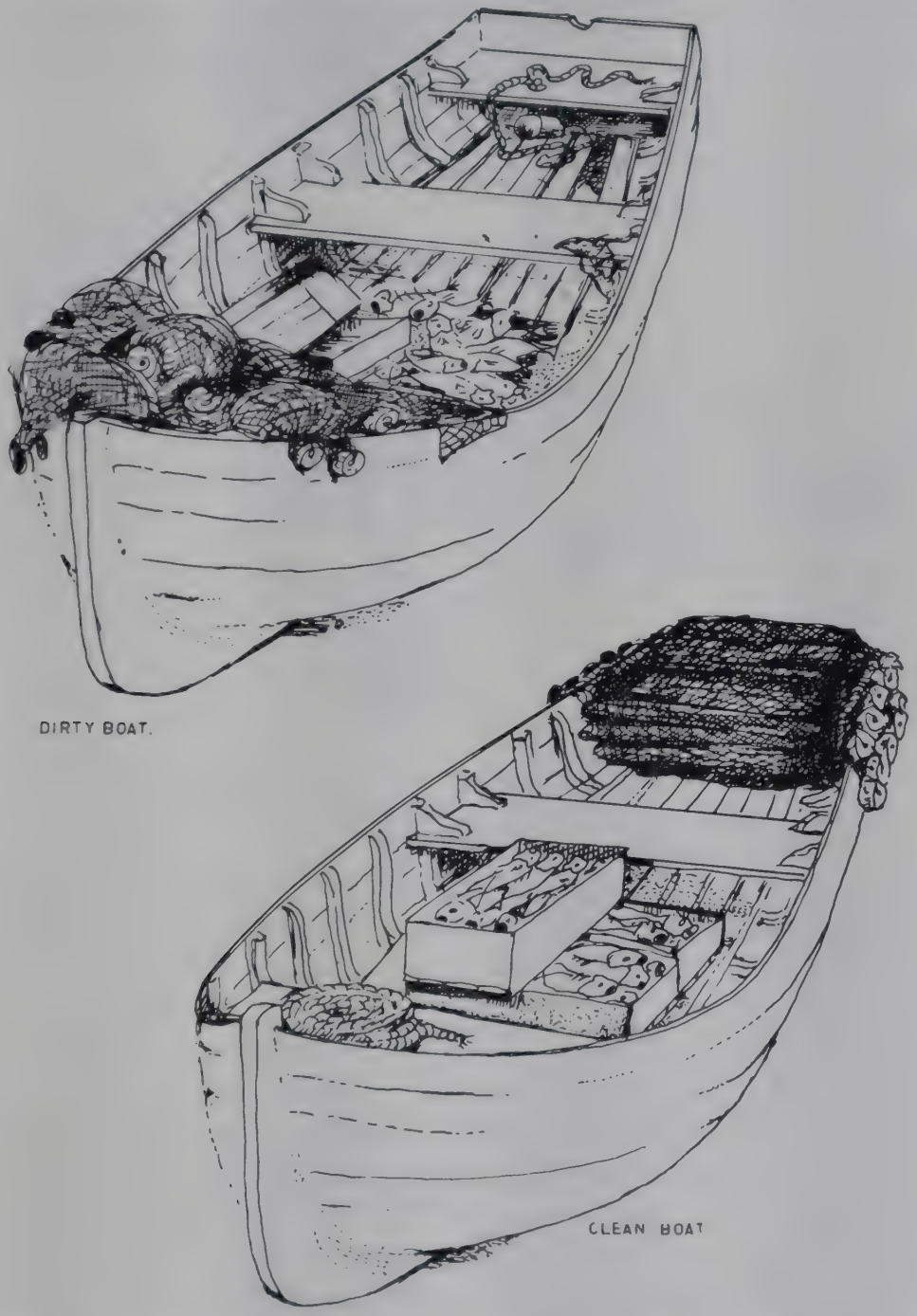


FIGURE 6. – *Comparison between a clean and a dirty boat.* Above: *a dirty boat, where rubbish, fish remains and filthy water create centers of bacterial build up.* Below: *a clean boat, where fish are carefully stowed and where, if ice is used, they will keep fresh for a long time.*

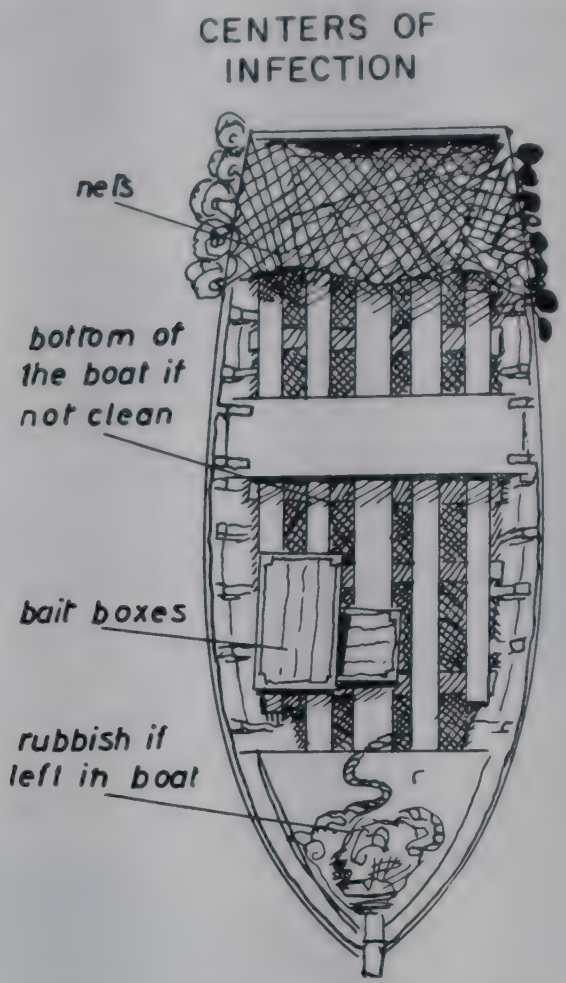


FIGURE 7. – *Centers of infection in a boat.*

position. It is not unusual to find fish caught in set nets or lines in a decomposed state. This condition applies before the fish have even reached the shore, so that some fish are worthless if caught by these methods.

How can such a problem be overcome? The best way is for the fisherman to stay with his line or net. In this way more work may be required, but the result is more profitable, because the fish do not spoil in the water. On the other hand the fisherman may run into difficulties if he stays out too long because fish already caught may spoil. He must learn to strike a fine balance among the conflicting factors of (*a*) the amount of gear he can work, (*b*) how often it should be cleared, and (*c*) his distance from market.

As already stated, when fish die, bacteria originally confined to the guts, liver and gills start to invade the surrounding tissues. If

the fish is exposed to the sun's heat in a dirty boat or canoe, a large bacterial population will attack the fish from the outside. Dirty boats contain pockets of bacteria which will contaminate the next catch of fish. All boats and equipment should therefore be kept spotlessly clean. The greater the initial population of bacteria the more rapidly fish flesh will be attacked and consequently spoil.

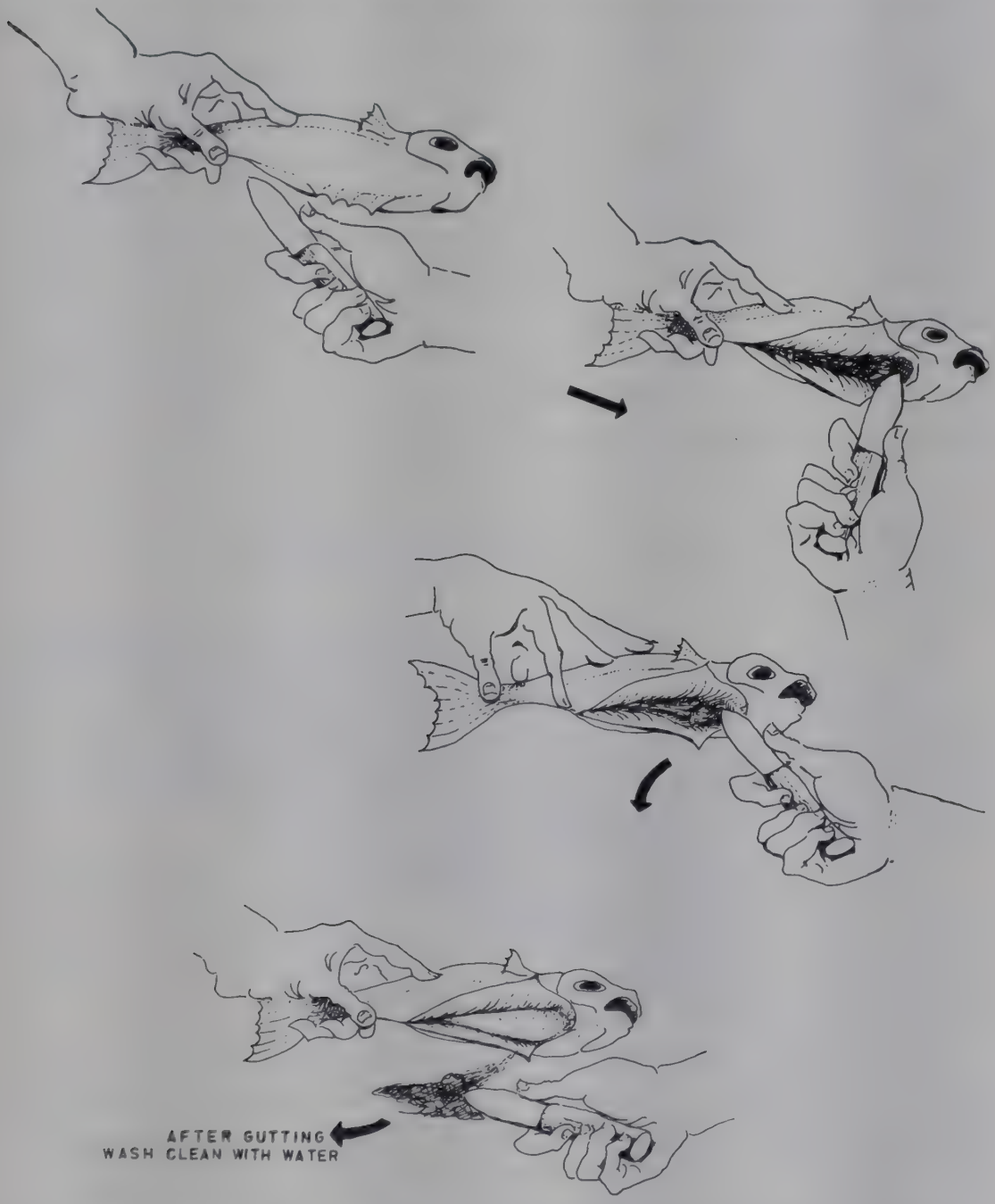


FIGURE 8. – *Removal of the fish intestines, showing the various stages of the action and the clean stomach after removal.*

Apart from ensuring cleanliness of boats and equipment, it is necessary to remove at once those parts of the fish with the highest bacterial concentration — the guts and gills.

The guts are removed by a knife cut from the rear body opening to the underneath of the gill opening. The stomach contents are then exposed. A cut across the body behind the head severs them, and the body cavity should be well washed to remove all the blood and small particles which may remain.

It should be noted that the removal of guts and gills is not generally practiced in West Africa because these parts are acceptable as food and the loss in weight reduces the market price of the catch. Nevertheless cleaning fish is highly desirable, and the reduction of spoilage by removing the centers of bacterial infection will, in fact, outweigh the value of the additional weight of ungutted fish. This is particularly true where icing and freezing are possible, because the better the initial condition of the fish the longer it will keep its quality. If there is a demand for offal it should be stored in special containers which are not in contact with the fish.

Some types of fishing gear and methods of fishing

Stake nets

Fixed nets, or pin chains as they are called in Sierra Leone, may vary in depth from a few inches to several feet. The mesh size is altered, depending on the size and type of fish to be caught. The setting may also be altered in such a way as to gill the fish or entangle it so that it cannot escape.

In order to gill the fish the meshes should hang in the form of a curtain across the direction in which the fish may swim. As the fish normally face the direction of flow, but are generally carried along with the current or tide, the best way to set is across the tide at right angles to its movement.

In entangling the fish it is essential that the net hang loosely, arising from the way in which it is set on to the head and footropes. The nets should be cleared frequently: otherwise the fish tend to deteriorate in the water and are often spoiling when brought to shore. This may involve more work for the fishermen but it is better that they should have a better product with a little extra work than

realize a poor price for fish which is decomposing. In Sierra Leone where certain boats (Snapper) go to sea for over a day, the problem of immediate preservation has been met by taking smoke barbecue ovens to sea. The oven usually consists of a section of a 44-gallon oil drum or similar sized portable grill. The fish are held rigid by a straight stick passed through from mouth to tail, and then smoke-heat cured over a small fire. This method removes the problem of early return to shore and waste of fishing time by traveling to and from remote fishing grounds. It could also be more widely adopted by fishermen throughout West Africa who are either line- or gill-net fishing over fairly long periods of time.

In shallow water or in river estuaries, an extension of the set nets can be used to make fish traps, by putting a break in the barrier with a cage at the end.

Set nets

Set nets are similar to stake nets but are fitted with weights on the footropes and the headrope is held up by floats. The nets are held in place by anchors at each end and the position of the net

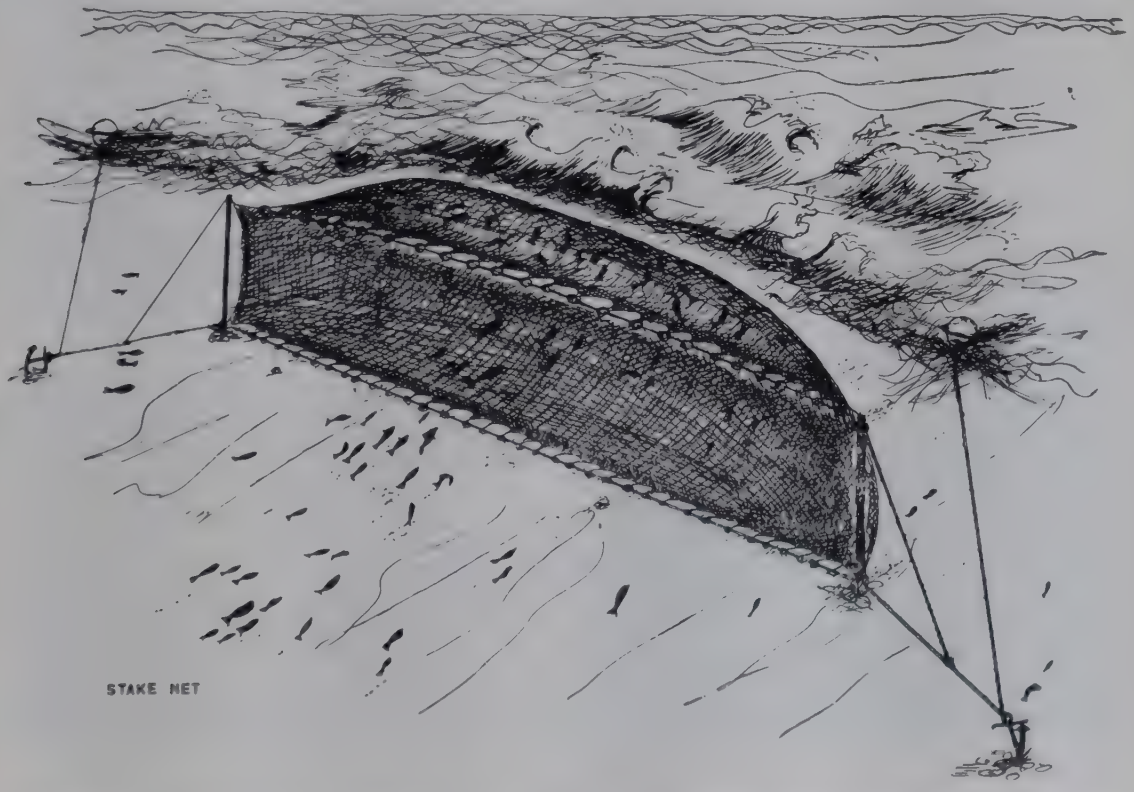


Figure 9. – *Stake net. This net has no floats or sinkers and is held in position by the stakes.*

is marked by floats. This is necessary because set nets can be used in much deeper water than stake nets, and may never be exposed by tidal movement. Some fishermen examine their set nets by hauling the net and shooting it later, while others just overhaul the net, letting it fall back into the water after the section being examined has been cleared of any fish. Nets being used in this manner may be left in the water for a considerable time, so that it is desirable that the netting be resistant to rot, if possible made of synthetic material.

Floating set nets and drift nets

Set nets can be rigged to fish on the surface or at any required depth by increasing the buoyancy and reducing the amount of sinker material. To fish a little way below the surface the net is attached to the surface rope and buoys by a series of ropes called strops. These can be of any length desired. Sometimes floating nets

Figure 10. — *Beach seine being hauled. The wings are already ashore and the bag is in shallow water. Some boys are in the water to free the net from obstructions.* (Courtesy of the Government Information Office, Freetown, Sierra Leone)

are attached to the fishing vessel, which then drifts with the wind or current. These are known as drift nets and a number may be joined together to the extent of several hundred yards for herring fishing.

Trammel

An extension of the tangle net principle is found in the trammel net which is difficult to fix, but extremely efficient. It has not been widely utilized in West Africa but should prove of value as larger fish can be readily caught in the pockets it forms. In effect it is three nets made up into a wall of netting. However, with the introduction of nylon, which makes such a good tangle net, the use of trammels is probably declining. Much the same effect can be obtained by setting in a net very loosely.

Beach seining, seining and trawling

The most up-to-date and efficient methods of catching fish on the sea bed are either by trawling or drag net fishing. These methods do not differ greatly from wellknown beach seining. Drag net fishing is carried on from the shore along the whole West Coast of Africa,

Figure 11. – *Sierra Leone seine fishing boat. Propelled by oar or sail, these boats usually stay at sea for a few days. A small portable oven is taken to sea, made of a section of a 44-gallon oil drum, as shown.*

but differs somewhat in technique and the types of net used; the principle, however, is generally the same. The net is taken to sea, shot from its carrying boat and slowly hauled to the shore by ropes attacked to each of the two wings.

With seining from a boat the same principle is applied, but in this case the boat plays the same part as the crew ashore in beach seining. It anchors in position where a good catch may be expected, and then shoots nets which may be as much as a mile from the boat. The net is hauled by winch, and as the wings come together, they drive the fish inward toward the bag, catching the fish as the bag moves forward. As this is a power operation it is quicker than shore seining, and being mobile it can be used easily in a variety of different places. This, in itself, is a great improvement on the primitive method in both time and production. It is of importance because the more rapidly fish is landed the higher is its quality and the more time is available for good preservation.

FIGURE 12. – *Examining the catch.*
(Courtesy Government Information Office, Sierra Leone)

Sometimes the vessel moves slowly forward after the net has been shot. This brings the hauling lines closer toegther more quickly and the speed of hauling is thus increased.

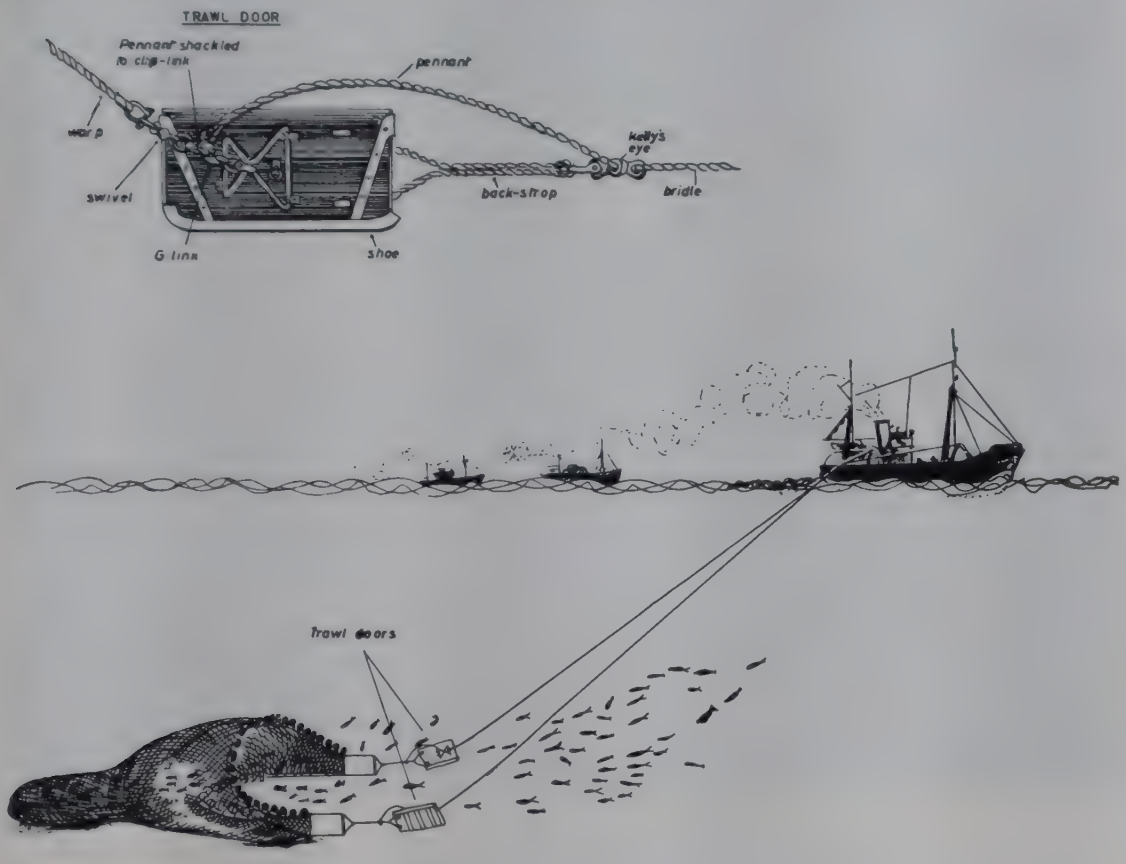


FIGURE 13. – *A trawl net in action. Variations of a trawl net have been made so that it can fish in mid-water or near to the surface, but the main principles of holding the mouth of the net open are utilized.*

TRAWLING

Probably more has been written about this subject than any other, and with good reason, as its introduction revolutionized fishing. The various types of trawl gear are too numerous to describe here, but there are two main types of value for use in West Africa. The standard bottom trawl is a bag, held open by trawl doors or boards and towed along the sea bed. The alternative mid-water trawl is set in such a way as to work at varying depths. This type is ideal for fishing herring and other pelagic species. Trawls can only be used on fairly smooth ground and not all ground where fish are to be had is workable.

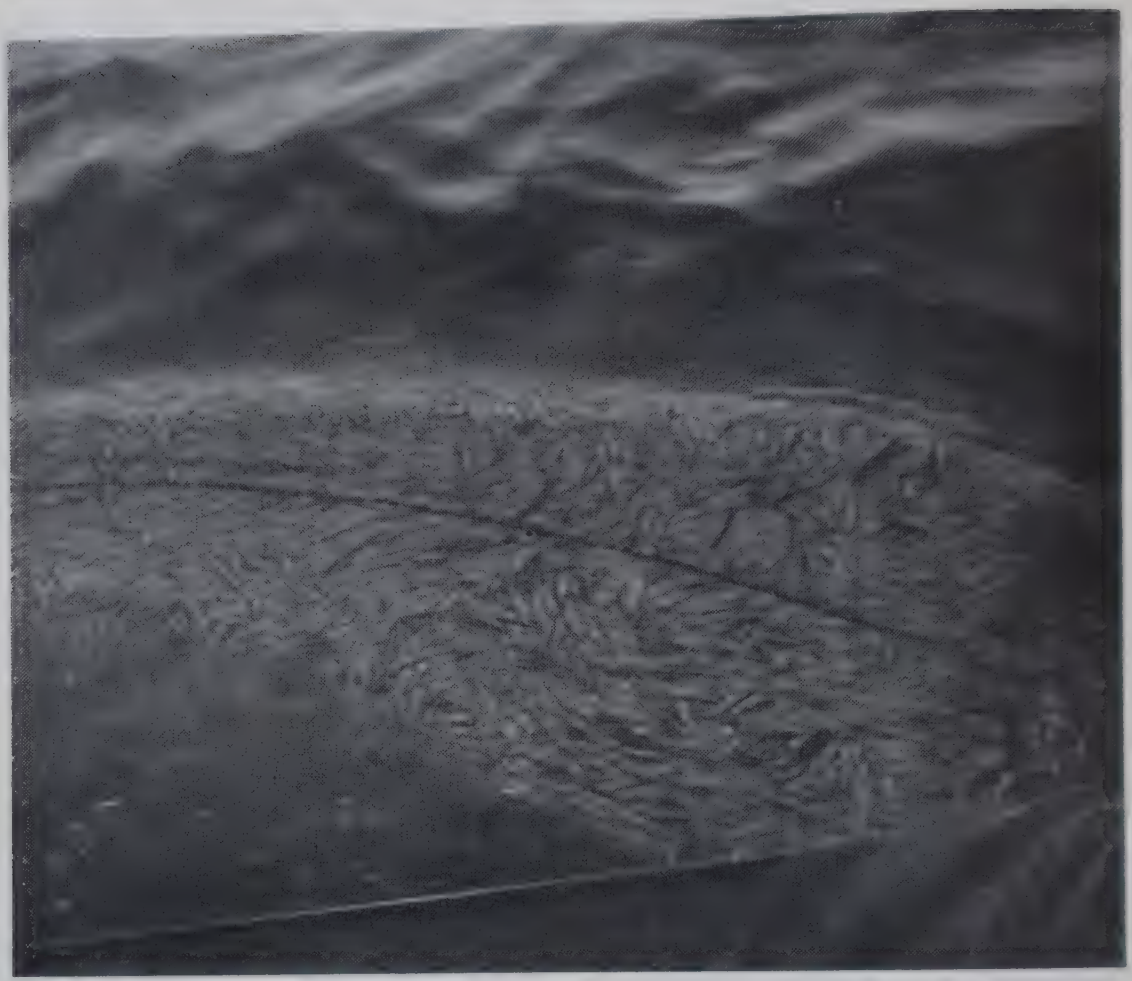


FIGURE 14. – *A large catch of sprats in a mid-water trawl. There are approximately 5 tons of fish in this net which were caught in an hour's tow.*

From the point of view of fish preservation, seining and trawling have one important advantage; the fish is caught quickly and often brought on board alive. But it is not possible to use these methods everywhere. Bottom set gillnetting and longlining maintain their importance. Danish seining, it should be mentioned, requires very highly skilled crews and has not yet proved very successful anywhere in tropical waters.

Purse seining - Lampara - net and ring - net fishing

These nets should not be confused with the drag type of seines: in complete contrast to these, they fish for schools near the surface. All these nets are expensive, bulky and heavy, and have to be used

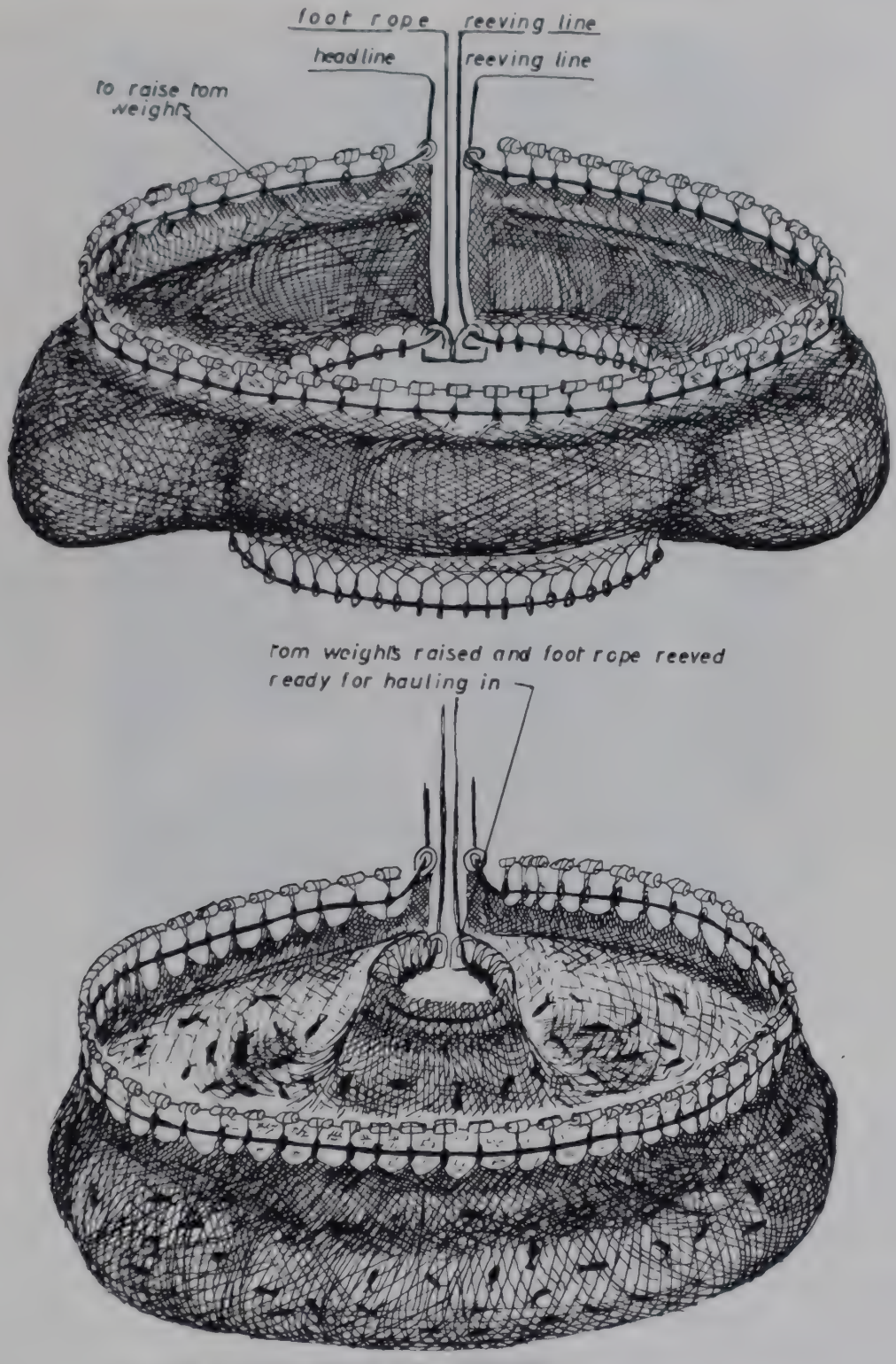


FIGURE 15. – *Purse seine. The net surrounds the fish and is held down by the weight of sinkers on the foot rope. Tom weights keep the ends of the net down when the pursing rope is being pulled in. When sufficient of the net has been hauled on deck to make a small circle closely packed with fish, they are scooped into the boat by dip nets or brailers.*

FIGURE 16. – *Sorting the catch. The bag of the seine net has been emptied and the fish are being sorted into head pans by the buyers.*

from large and expensive craft. However, where large schools of pelagic fish are to be found, they have a great catching capacity and permit fish to be brought very rapidly to the boat. The net is shot over the stern of the boat, which steams at full speed in a circle to enclose a school of fish. Lead weights make the net sink rapidly but the fish are free to swim within the encircling net, at the foot of which there is a series of rings through which a rope known as the pursing rope is passed.

A winch on the boat brings in this rope, which has the effect of drawing the bottom of the net forward and together. It eventually

encloses the school of fish in a large bag of net, so that as the bag is reduced in size on being hauled aboard, the fish are increasingly confined.

Eventually fish can be brought out of the net by the use of a series of dip nets or brailers. There is no damage to the fish; they are invariably alive and the whole process takes less than one hour.

Methods of fishing

Originally, for the purpose of fishing, man must first have ventured into the water in the most primitive of all craft — a floating log. After developing primitive implements and discovering how to use fire, he was able to remove the center of the log; thus the first dugout canoe was made. It was a small step to erect a mast and make use of sail to travel much longer distances. The dugout canoe has remained the craft of many countries throughout the world, and some are beautiful examples of their builder's skill. The proa of Samoa and ngalawa of East Africa are very narrow and fast but need extra small flat floats at the side for stability. These floats are called outriggers. The Ghana canoe is ideally adapted for surf landing and can be easily righted if it overturns. Sierra Leone has many dugout canoes which must rank as some of the most delicate and functional of all fishing canoes. One man may operate the canoe for line fishing and in the course of a day may travel many miles by paddle alone.

As a logical development of the dugout canoe came the plank-built craft, but this requires suitable materials and skill to build the right type of vessel. Sierra Leone, for example, has developed a very fine tradition of boat-building, and large dugout canoes are outnumbered by the more conventional plank-built craft.

The main form of propulsion in the 19th century was by sail or manpower, but with the coming of steam, followed by the internal combustion engine, bigger boats became possible. Engine propulsion resulted in rapid development in craft and equipment in the heavily industrialized countries, but many developing countries still rely to a large extent on dugout construction, using manpower or sails for propulsion.

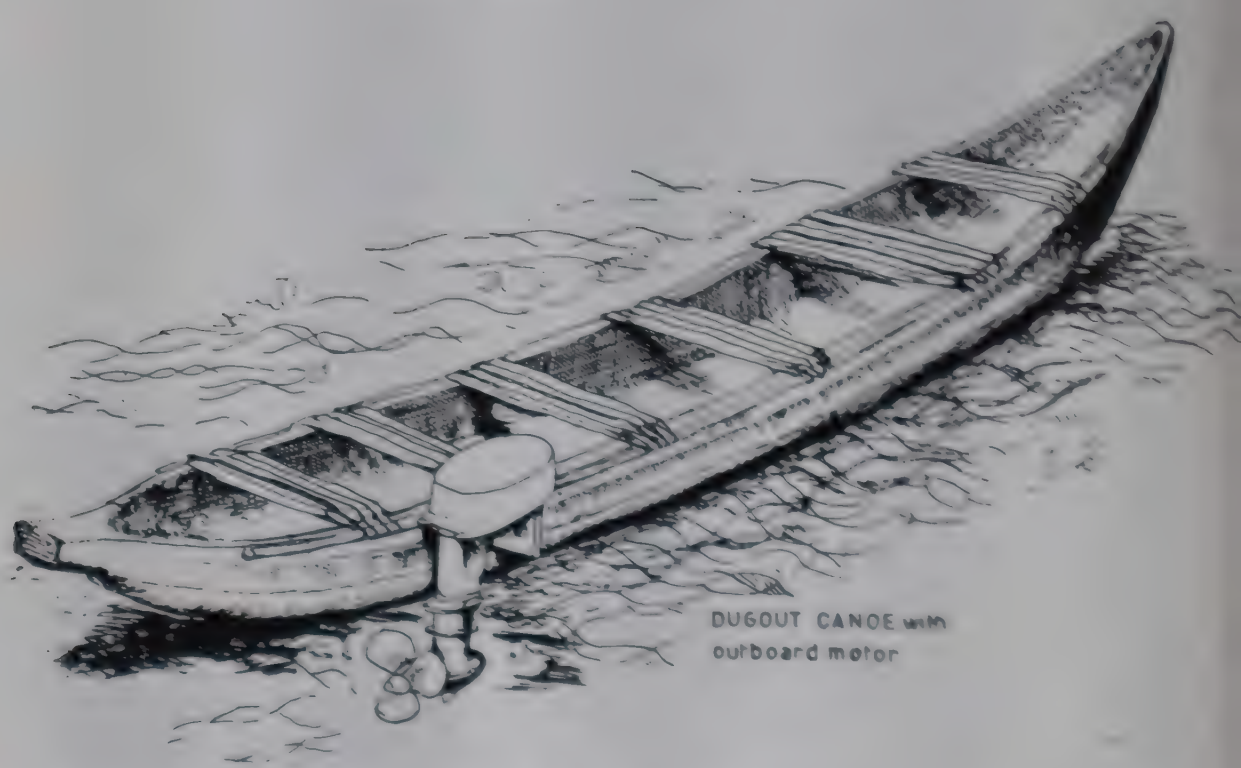


FIGURE 17 — Above: *a plank-built boat propelled by an engine.* Center: *a dugout canoe propelled by paddles.* Below: *a dugout canoe with an outboard motor fitted.*

FIGURE 18. – *A Ghana canoe at speed with outboard motor attached.*
(Courtesy Government Information services, Accra, Ghana)

Mechanization

Fishing voyages vary in duration from overnight, in the case of small inshore canoes, to many days, even weeks for large vessels. Longer voyages mean that the construction of vessels must be more complex, in order to deal with the additional propulsion, catching and preserving problems.

A canoe propelled by paddle at three miles an hour to fishing grounds twelve miles from the home base will take four hours to

FIGURE 19. – *Outboard motor on a Ghana canoe.*
(Photo: Shell Co. of Ghana)

reach the grounds, and a similar period to return home after the day's fishing. Usually some auxiliary power such as wind is utilized but it is more reliable to have a motor. The most easily adapted even if it is not entirely satisfactory, is the outboard motor, driven by petrol and of a light construction. A Ghana canoe requiring about ten men to paddle it can go along at about 10 mph with an 18 hp motor. The result is that fishing grounds are reached quickly and catches arrive at the market in much better condition. A good example is to be seen during the Ghana "herring" season, where "herring" (*Sardinella*) from powered canoes reach the market first. (This is a great advantage for canning; the fresher the fish the better the quality of the canned product.) From outboard motors the next logical development is to have an inboard motor fitted, but many dugouts are unsuitable for such development. Therefore it becomes necessary to build a planked craft around a framework

which, incidentally, saves a lot of time and timber (in some countries timber is becoming scarce) with an engine installed to provide the motive power. An engine also provides power to work a winch and a generator, both essential for more complex fishing operations, and also for the freezing of fish at sea if this is desirable.

Mechanization enables boats to travel to existing fishing grounds more often, and also to reach more distant grounds; it will also result in bigger catches. Increased capital and running costs must, of course, be offset by better monetary returns. More efficient gear and mechanized propulsion are of limited value if the catch can neither be sold in the fresh state nor preserved at a cost which enables the fish to be marketed at a price within reach of consumers' pockets.

It is essential that the various aspects of development are harmonized so that a better product reaches consumers in greater quantities and at reasonable prices. There is no point in making bigger catches and landing fish in better condition if the shore facilities are such that the fish goes to waste on the quay. Questions of transport and storage are also important in this context. All too often in tropical countries the regrettable situation is found of insufficient fish in poor condition reaching too few consumers. Prices are excessive and yet the fishermen have only poor earnings.

4. FISH SALTING

The use of salt to preserve fish and meat has been known for hundreds of years. Preference for other methods as they have developed has led to a decline in the popularity of salting, but Nigeria still has a market for salted and dried fish. Where salt is available in sufficient quantity, is cheap and of good quality, then the process is simple and effective and requires no elaborate equipment or techniques.

The smoking of fish is usually preceded by a period of salting (also known as rousing) and the finished product is said to be smoked because this is the major part of the process.

Action of salt

Salt in itself does not possess antiseptic qualities. In fact, bacteria need a little salt for their growth and some grow far better when it is present. Salt preserves fish by extracting water. When packed in a suitable container with salt, in a short space of time enough water is extracted from the fish to cover them. As water passes out of the tissues so salt passes in, and eventually there is a balance when no further interchange can take place. As the salt passes into the cell tissues the cell liquids become a concentrated salt solution. This action is known as osmosis.

Osmosis takes place because the cell walls act as a semi-permeable membrane, allowing the water to pass out and some of the salt to pass in, but the colloidal proteins in the cells are retained. As noted earlier, spoilage is caused by bacteria, and chemical processes known as enzyme action. Both actions are slowed down by salting.

Bacteria are one-cell organisms and just as salt acts upon fish cells, so it acts similarly on bacteria, causing the water to pass out

and collapse the cell. As little as 4 percent salt solution in the body tissues retards enzyme and bacterial spoilage and if it can be raised to 20 percent then good preservation results. As with smoking or drying, salting must be carried out before spoilage starts to set in. Speed of handling is therefore essential, particularly in high temperatures.

Composition of salt and its effect on fish

In its pure form salt is sodium chloride, a combination of sodium and chlorine, but much commercial salt is obtained from evaporation of sea water and this is a combination of the salts of several elements. The main ones, in addition to sodium, are calcium and magnesium. Both of these have a bad effect on the preservation of fish because they cut down the penetration of sodium chloride, allowing decomposition to take place. So if fish are somewhat stale when processed, it is unlikely that an effective cure will be obtained unless the salt is pure.

Another effect of calcium salts is the coloration produced which may range from pale yellow to white. A yellow color is obtained with pure sodium salt, but as the amount of calcium salt is increased, so the color ranges toward white (this may help the producer who may have to cater for different color preferences). When preserved in salt containing magnesium or calcium chlorides fish become rather brittle.

Summary of salting methods

Brine salting (brine cure, wet cure) — preservation of fish by immersion in brine

Dry salting (dry cure) — curing fish by adding dry salt

Kench salting (kench cure) — salting fish in piles which consist of split fish and salt placed in alternate layers thus allowing the pickle which has formed to drain off freely

Pickle salting — treating fish with dry salt in watertight containers and curing in the pickle which forms as a result

Brine (brine pickle, pickle)
— 1. Salt solution (brine) used to cure fish
— 2. Liquid formed in dry-salting fish as salt dissolves in water extracted from tissue juices

METHOD OF OPERATION

Generally speaking, the sooner salt is applied to the tissues the better will be the preservation. The action is dependent on direct contact; it is therefore desirable to expose as large a surface as possible to the salt. Small fish such as herring can be done in the round, but larger ones must be headed, split, and have the intestines, centers of spoilage, removed. In small fish such as herring this is not practicable for the numbers are so large.

It is essential to prevent bacterial action by using large quantities of salt and by working quickly.

A combination of salting and smoke-drying is ideal. A certain amount of heat destroys enzymes and bacteria, and the salt completes the cure. Alternatively, the fish may be placed in salt before smoke-drying commences. The effect of high temperatures can be limited if the fish is chilled and a salting process is also possible with the use of ice. This may raise the cost, but its use gives extra time in which to effect a good cure by suppressing spoilage until the preservation process is started. If ice is available the process is as follows:

1. Put the fish on ice immediately they are caught — equal weights of ice and fish are advisable.
2. Head, gut and split the fish along the backbone.
3. Put plenty of salt between each layer and sprinkle with a little crushed ice. This will tend to dilute the final solution (pickle) but will have the advantage of keeping the temperature lower a little longer and give the salt more effective processing time.
4. Use only the purest salt for the cure (complete absence of calcium or magnesium salts).

Storage of salt fish

Salt fish is very susceptible to spoilage while being stored so that care must be taken in keeping the product. One very important consideration is the rancidity of fat in the tissues, caused by fats or oils taking up oxygen. *Sardinella aurita* appears to possess an anti-oxidant but it is not known whether shad (Ethmalosa), the other common species caught in quantity in West Africa, has the same characteristic. If the fat shows a tendency to oxidation then storage at low temperature is required and a cold store is essential. As the object of preservation is to obtain a good product in an economical way, salting is not always the best method for certain fatty fish.

White fish such as shark have been dried after salting; this is mentioned in the chapter on smoking and drying.

Reduction of water content for fish containing little fat means that there is small chance of spoilage and the product will keep well.

Summing up, it is most advisable when salting fish in the tropics to observe certain rules.

1. Use the purest salt available.
2. Use sufficient salt.
3. Store the fish:

(*a*) in a sufficiently dry condition to slow down bacterial activity;

(*b*) if oily, in cold storage or in brine.

4. To combine the salting with another method of preservation, e.g., smoked/salted and dried, is a most effective method. Salting will reduce the water content rapidly, heat will increase the drying process, inhibit the enzyme and bacterial activity, and smoking will complete the cure while imparting the characteristic flavor.

Brine or salt from sea water

Certain parts of the West Coast of Africa have good supplies of salt in tidal lagoons and where these can be worked they provide cheap supplies for preservation and domestic use.

If geographic conditions are suitable, low-lying areas may be

flooded with sea water which then evaporates. When the water content is well reduced, final evaporation is carried out by the application of extra heat: the caked salt is then roughly crushed for packing. Ghana has lagoons which periodically flood from the sea and then dry out, providing a natural source of salt. One very large lagoon lies to the west of Ada at the mouth of the river Volta. Salt supplies from this source depend on flooding at the correct time and suitable climatic conditions for evaporation.

Where salt is produced on a commercial scale, the tidal-zone areas of the rivers are walled off to hold back the salt water after it has filled up the area of the flood tide. Sluice gates permitting the inflow of water are kept closed and the water held back evaporates thus increasing the proportion of salt in the remaining liquid. When a sufficiently high level of concentration has been reached, the liquid is pumped into the final evaporating tanks. As the solution becomes oversaturated — that is, the salt can no longer be

FIGURE 20. – *Extraction of salt from lagoon in Keta (Ghana).*

(Photo: Ghana Information Services)

held by the liquid — it is removed for drying and crushing. Although this product is suitable for salting fish, its efficiency will be reduced by the calcium and magnesium salts it contains.

FIGURE 21. – *Scooping salt from an evaporation pond in Ghana.*

In deltas such as those in Nigeria and parts of Sierra Leone geographic and climatic conditions do not permit of salt production on a large scale. In the tidal zones, however, salt may be obtained by evaporation using mangrove wood which is abundant for fuel. A 44-gallon drum, cut in half from top to bottom, may be used. The two halves, filled with salt water, are placed over a fire and this, together with the action of the sun and wind, will rapidly reduce the level of the liquid. The drum should be kept continually topped up with water. The yield from this method is not high, but where salt is not otherwise obtainable, or too expensive, it is a simple operation and the equipment required is rudimentary.

5. FISH SMOKING AND DRYING

Smoking is a long-established method of preserving fish. The discovery of fire led to the preservation of food by cooking or smoking, and later these techniques were employed to ensure more regular food supplies, despite seasonal fluctuations in the supply of the fresh product. Sun-drying in suitable areas may have been done together with smoking; drying is probably the oldest (and certainly the cheapest) method of preserving fish and is dependent on climatic condi-

FIGURE 22. – *Fish drying on racks in the sun.*

tions. A combination of salting and smoking, long used in Europe, can be very successfully employed.

Smoked fish is popular and within reach of the pockets of most communities.

Smoking

Basically, the whole process of smoking is a combination of three factors which determine the time and labor involved, the extent of the cure and the resultant flavor, and are namely:

1. Salting: extracts some of the body liquid, thereby assisting the drying process.
2. Smoking: gives the fish its flavor and characteristic dark brown color. The keeping qualities are improved by the antiseptic action of the smoke.
3. Drying and cooking: the skillful use of different quantities of wood for heat and smoke will give the type of cure desired.

As noted earlier, the water content of the fish is roughly three quarters of the body weight, but if the water is reduced to 40 percent, then bacteria have difficulty in multiplying and the fish remain in good condition. Such reduction of water requires that sufficient heat be applied and sustained over a sufficiently long period to ensure that the correct amount is removed. No accurate measure of water loss can be made: the only way in which the process can be regulated is by the amount of fuel and the height of the grill.

Two types of smoking are in general use — cold smoking and hot smoking.

Cold smoking

Cold smoking is usually done at 27 to 54°F (15°C to 30°C). This process is not general in the tropics because at high temperatures and humidities spoilage is likely to overtake the cure and ruin the fish completely.

The only cold-smoked herring of historical importance was red

FIGURE 23. – *The late Maurice Pate, formerly Executive Director of* UNICEF, *examining stocks of dried fish in Senegal.*

herring. This was the well-salted herring, smoked for several weeks until it was well dried, and of a reddish brown color. The result had a very strong flavor, and before it could be used had to be soaked in water to soften and remove some of the salt. Yarmouth bloaters are prepared in this manner but have much less salting and smoking. Kippers and smoked haddock are examples of modern cold-smoked fish. A kipper is a herring which is split open, cleaned and then smoked by hanging on a rack after a short brining period. Haddock is a white fish of the cod family and is preserved in a similar manner to the kipper. The whole fish, if small, may be used, or a fillet where large fish are being dealt with. It should be emphasized that cold smoking is a form of curing rather than one of preservation and the fish will keep for a few days only. The sole advantage, therefore, of fish processed by this method is its good flavor.

Hot smoking

Hot smoking requires greater heat. Temperature control is achieved by increasing or decreasing the amount of fire beneath the smoking racks, or altering the height of the rack in relation to the fire below.

The action of the heat is twofold: in the first place, it barbecues the fish, and secondly it sets up hot air currents ensuring a flow of air over the fish to conduct moisture away.

The process involves two actions to remove moisture from the body tissues:

1. Application of salt in which osmosis extracts liquids through the cell walls and penetrates the cells on a small scale, thus reducing cell water content.
2. Further reduction of moisture content by the action of hot air currents.

In high humidity areas there is limited reduction of moisture content unless sufficient heat is applied. The process should also take place in a confined area with low humidity. Thus a smokehouse will be relatively less humid than an outside oven exposed to ordinary climatic conditions. Due to this factor, preserved fish will remain in better condition if kept in a smokehouse than in a dwelling or storehouse.

The African hot smoking process differs mainly from that found in Europe in that there is no salting in the former — due to the lack of salt supplies, to some consumer prejudice against salt fish and also to the high cost. Smoking is a longer process in Africa but until recently, when smoking kilns were developed, little improvement on the original, simple process had been made.

Some existing smoking methods in use in West Africa are described below, noting simple improvements in design and technique to obtain the best results.

Fuels used in smoking in West Africa

In Europe, before the trees were cleared to make way for cultivation, fuel for smoking presented no problems; this is still true in some parts of West Africa. However, difficulties in obtaining

fuel increase as the coastal areas are developed. Forest clearance for housing, agriculture and the sale of timber all reduce the supply of fuel. Alternative methods of smoking may have to be found, or the smoking process must be so organized as to incur lower costs.

For example, the main expense involved (after smoke ovens have been erected) is for fuel, so that costs are halved if twice the quantity can be processed with the same amount of wood.

The particular type of fuel to be used depends largely on the particular locality and also the type of cure desired. By comparison with other woods the results from mangrove appear to be very good: it has little alternative commercial value so is to be strongly recommended. In deltas, it is the quickest growing and most readily available fuel; it has good smoking qualities, is easily obtained and is abundant. On coastal strips where coconuts grow, the husks make good hot fuel but produce little smoke. Guinea corn stalks are often used, and driftwood, sawdust and mahogany or cedar waste give good results. Other vegetation may be used; the limiting factor is the availability of adequate supplies.

The type of material usually used to " hot-smoke " fish varies but in certain processes — in Ghana particularly — preservation is usually completed with a different type of wood which increases the smoke and imparts a stronger flavor to the preserved fish.

Some methods of smoking

Most smoking ovens are simple in construction and do not permit the most efficient use of fuel and labor in handling the fish, which are dealt with individually rather than in batches. Obviously, it is an economy if fish can be handled in quantity by one person. With improved ovens and bulk handling more fish can be processed, thereby reducing prices, and at the same time stimulating production.

The simplest type of oven is an open grill on which the fish are laid with a fire smoldering below. These are to be found in a few scattered villages where catches are small, but are not widely used and are really suitable only for dealing with small catches.

Construction of a smoke grill is carried out as follows:

Y shaped stakes 18 in × 3 in (46 cm × 7.5 cm) are connected by cross members and the bars of the grill, usually wood, are laid between.

Another type of grill is made from weld mesh. A suitable wood to use is red mangrove which is available in abundance in the

FIGURE 24. – *Two traditional ways of smoking fish.* Above: *the Sierra Leone smokehouse.* Below: *the Ghanaian oven.*

estuaries. It should be noted that as the fire is open to the prevailing wind, its efficiency is not high; upward hot air currents often miss the fish completely. This type of grill is simple to construct, and may be of value in mobile camps where lack of facilities and time make the construction of more elaborate equipment difficult. It could be improved considerably by fitting side walls of woven palm fronds, or similar materials, so that heat and smoke is directed on to the fish rather than allowed to be dispersed by the wind.

An enlargement of the open air grill is the commonest of smoke ovens to be found. The grill or grills are erected in a house of either rush or mud construction which is usually thatched. The fish may be rubbed in sea sand and placed on the racks in layers. The fires are moved along below the grills as more fish are added and no control of the smoke is possible. As the racks become full, some of the earlier fish tend to deteriorate and become infected with beetles and grubs. The fire is then moved back and more heat and smoke is applied until the fish is re-cured. This method is rather wasteful and inefficient, and often results in a poor cure. However, there are many good points to these smokehouses and they should be seriously considered because good results can be obtained with small improvements.

The Stevens Report on Sierra Leone (1945) stated: " . . .in the primitive types of drying houses in general use, high grade preservation is impossible — more particularly because quick sterilization in the early stages is essential. For this purpose so much initial heat must be applied that the fish is partly roasted. The finished product is both dried and smoked." The fish may range from dried charred specimens to really well-preserved ones, which is more the result of chance than the present smoking techniques in use.

The Ghanaian smoking ovens

Ghanaian fishermen have migrated extensively along the West African coast, taking with them their catching as well as preserving skills and methods. For smoking they have a traditional oven made from mud, either round or rectangular in shape.

The construction of the oven is quite simple and consists of layers of mud, each layer being 9 to 12 in (23 to 28 cm) in height, and 4 in (10 cm) thick. When these layers of mud dry out, a fresh layer is

FIGURE 25. – *Smoking ovens at Anomabou, Ghana.*
(Courtesy Meschkat)

applied until the height at which the grill bars are to be placed is reached. They are placed usually 2 ft 6 in to 3 ft (75 to 90 cm) from the ground: anything lower would result in burning the fish. One layer of straight wooden sticks may be reinforced by another running at right angles. More recent ovens have had grills of weld mesh as an alternative, but the drawback to this is that it tends to cause searing of the fish where it comes into contact with the metal.

The oven has a small entrance door for tending the fire and the fish are laid on the bars in layers and occasionally turned. The ovens are in the open and have covers to protect the fish and prevent destruction by rain: these covers also confine the smoke and heat. It is notable that the peak season for catching fish in Ghana is during the rainy season, when humidity conditions are at their highest, calling for care in operation and storage. One woman may tend several ovens, but the output is limited by the need for her constant attention to the fish during the process, which may last for several days, depending on the degree of preservation desired.

It is interesting to note that at Conakridi in Sierra Leone a settlement of Ghanaian fishermen have compromised with the local fishermen in that they have their traditional ovens in a hut or banda: this must be on account of the extremely heavy rains. It does permit a large number of ovens to be concentrated in one area with no risk of destruction by rain and the minimum inconvenience to persons doing the smoking. This is probably the nearest approach to a European smokehouse.

The process itself varies with the skill of the individual, but usually after the fish have been scaled and washed they are rubbed in sand and laid in rows on the grill. When sufficiently smoke-dried on one side they are turned to ensure as even a cure as possible. If supplies are limited and demand high then only a light smoke is given but if long preservation is desired, a fairly long smoking is given. All available materials are utilized: coconut husks in particular are favored for their heat-producing qualities.

Variations on the Ghanaian oven

As herrings are migratory during the main season, it is not always possible for the fishermen to stay in one home village. This has resulted in a simple but effective substitute for the oven being made from oil drums with the same dimensions as the mud oven. The drums are cut open and flattened, and then bolted together to form a sheet which, when long enough, can be made into a circular oven. Metal lugs or holes for bars are cut into the sheet. A grill of either weld mesh or bars is fitted to carry the fish and the process is then similar to that for the mud oven. Because it is easy to erect and transport, this type of oven is becoming very widely used.

Now that fishing methods have changed in Ghana and very large quantities of " herring " are landed at Tema, there is need for larger types of oven which are more efficient in operation. To hang the fish so that the whole of its surface (both sides) is exposed to smoke and heat at the same time, and so that no marks of the grill appear on its surface, is a possible improvement. However, hanging requires more space and initial preparation.

In Abidjan, Ivory Coast, oven design has been modified; instead of the round oven, a rectangular one is used which is considerably larger.

A SIMPLE TYPE OF SMALL SMOKING OVEN

The traditional types of smoking oven already mentioned are simply grills on which fish are laid over fires; they do not make the best use of the smoke and heat. The ideal oven permits

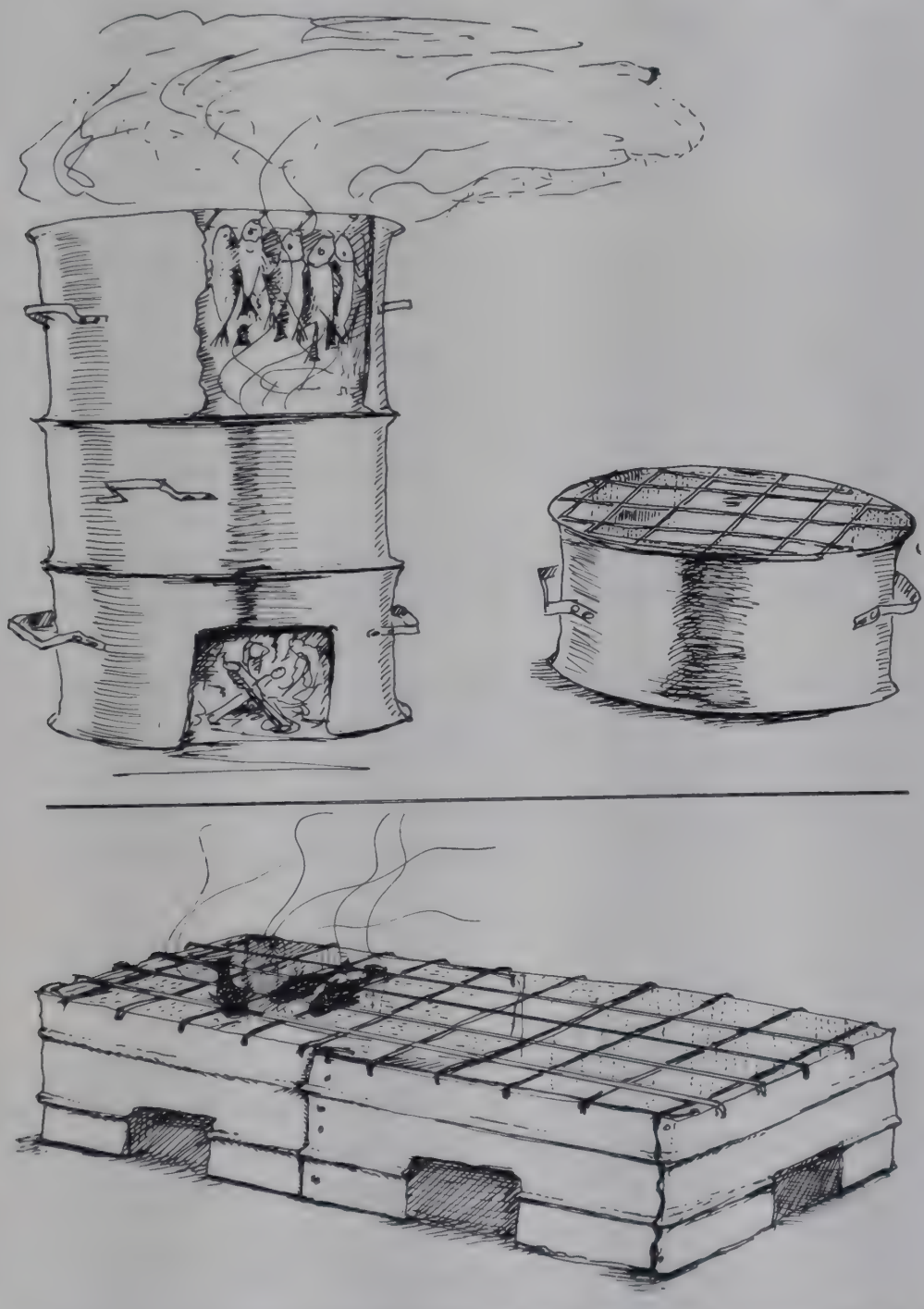


FIGURE 26. – *Two simple smoking ovens made from 44-gallon oil drums.* Above: *oven made from sections of a drum.* Below: *oven made from whole drums flattened and joined.*

maximum efficiency in preservation with minimum of fuel and effort.

With these requirements in mind a small type of oven using a 44-gallon oil drum has been devised. It is cut into sections horizontally, the fish being hung in each section. If the sections are placed on top of one another over a fire, then a large column several feet high is made and fish can be smoked in quantity using a limited supply of fuel. The fish are handled in sections and not individually. This permits speed in handling and enables a greater number to be handled by one person after the initial filling of the section has been done.

The piles of sections are several feet high and fish hang on hooks in a tower up to 20 ft (6 m) high.

It has been mentioned that the traditional method is to lay fish on the grills, but in this type of oven the object is to hang the fish so that the hot air rising and flowing over them smokes and dries all surfaces at the same time. No scorch marks from the grills will develop by this method.

As the lower sections are nearer the fire it is necessary to interchange them occasionally to ensure that all the fish are evenly cured.

This oven is easy to construct from local materials, and there should be no difficulty in developing it on a wider scale. It can be moved easily from place to place, being light and rigid, and this is particularly useful for fish which are migratory and where the fishing fleet is constantly on the move to keep in touch with the shoals.

Method of construction

Most 44-gallon drums have a ridge one third of the depth of the barrel from each end. When cut on these ridges the sections are of even size and also have a readymade flange to enable them to be joined together easily when placed on top of one another during the processing.

Badly battered drums should be avoided. They will not sit evenly on top of one another, with the result that the whole column is unstable and the hot smoke escapes through the gaps. If damaged

drums have to be used they should be beaten to as regular a shape as possible.

The lowest section usually holds the fire, or it can be built in a pit below with a small flue made by digging a trench and covering it with wood or sheet metal. A small opening 7 in × 9 in (18 cm × 23 cm) is cut in the base of the section to admit the wood.

The handles must be as near the top of the section as possible, to maintain its stability when handling. The drum being metal, the handles can be simply made from loops of strong wire through holes drilled in the sides, as shown in Figure 26.

Now the question arises of placing the fish in the section. If the fish were to be laid on a grill, the capacity of the section would be the surface area of the sides of the fish, but little vertical space would be occupied. In this way only a few fish per section would be possible, and the arrangement would be little different from that of conventional ovens. If, on the other hand, the fish are hung, they take up vertical space in the section but little of the area.

As the hot smoke rises, all parts of the fish are smoked and dried evenly, without any further handling being required, apart from occasional changing of positions to ensure that all sections get the benefit of the greater heat near the fire.

To prevent smoke escaping too readily from the places where the sections meet and from the top, strips of damp sacking are placed on top of the oven. These must be kept damp or they will scorch. One woman can supervise six or seven of the ovens at the same time, each oven holding about four times as many fish as the traditional type, and the fuel required is considerably less. No scorching or searing of the fish should occur and an evenly preserved product should result.

FAO STUDY IN THE IVORY COAST

Between 1963 and 1964 an FAO expert, Mr Erik Christiansen, made a study of fish preservation in conjunction with fishery personnel in the Ivory Coast. In the course of this work he tried out three different types of smoking oven, the traditional type used in the country, the Altona oven, and a modified type of traditional oven.

Traditional-type square ovens measuring 6 ft 7 in × 6 ft 7 in (2 m × 2 m) are constructed with old oil drums. Five drums are required to construct the outside of the oven and one to divide the oven into two parts in order to avoid excessive draught. The barrels are joined together by means of metal strips $^{1}/_{2}$-in (2 cm) in width (see Figure 29).

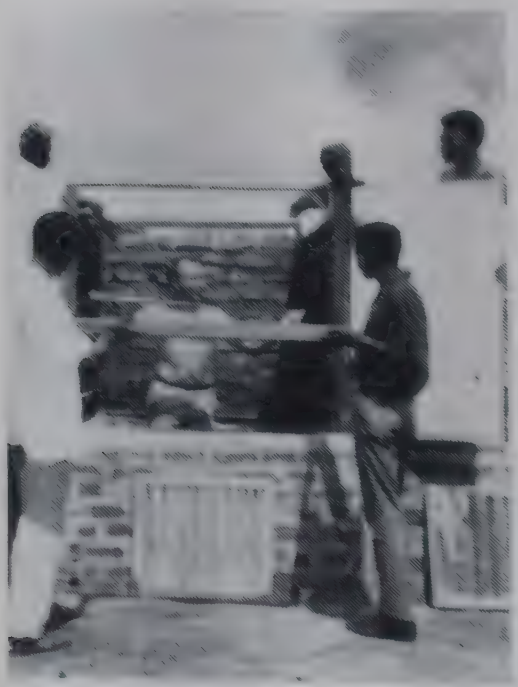


FIGURE 27. – *The Altona-type oven being constructed in Nigeria.*
(Courtesy Piatek)

FIGURE 28. – *The completed Altona-type oven.*
(Courtesy Piatek)

The second type of oven tested was the Altona with a framework made of $1^{3}/_{10}$-in (33 mm) angle-irons and the fish was placed on grills framed with wood which fit into the angle-irons (10 layers). The oven is lined with $^{1}/_{4}$-in (1 mm) sheet iron and there is a corrugated iron roof, which is raised $^{4}/_{5}$-in (6 cm) above the sides so as to enable the draught to be regulated. The dimensions of the oven are 5 ft 8 in × 5 ft 8 in (1.72 m × 1.72 m) and 8 ft 3 in (2.2 m) in height. The oven has 20 frames, each measuring 2 ft 9 in × 5 ft 7 in (0.85 m × 1.7 m).

The third oven tested was the traditional type as improved by Mr Christiansen. The dimensions were 6 ft 7 in × 6 ft 7 in (2 m ×

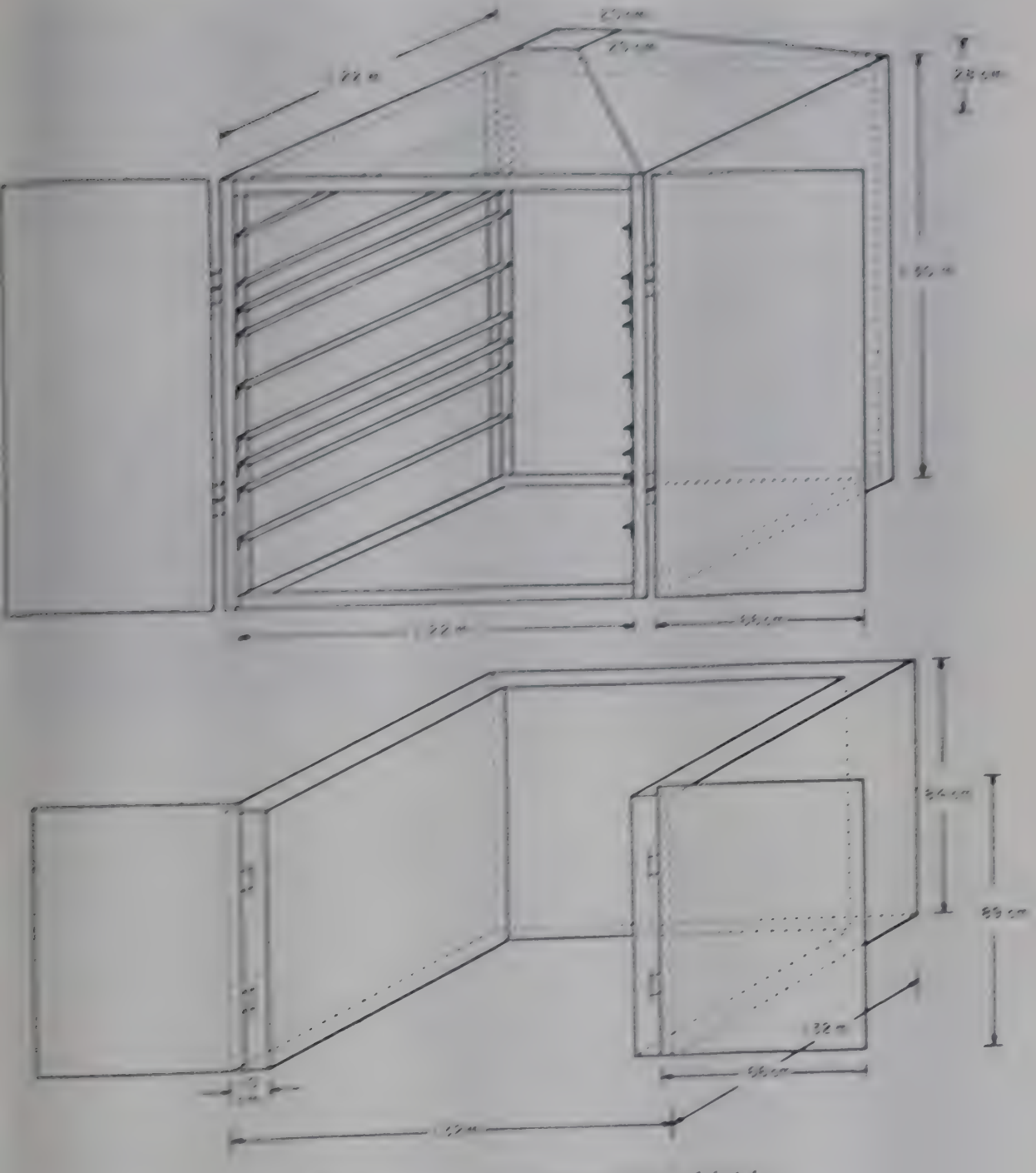


Figure 29. – Altona-type oven (lower part of brick).

2 m) and 2 ft 11 in (90 cm) in height. These dimensions were chosen to correspond with the standard sizes of sheet iron and the racks.

The modification of the traditional oven uses old oil drums for the fire. Being thus enclosed, the oven may be constructed with any

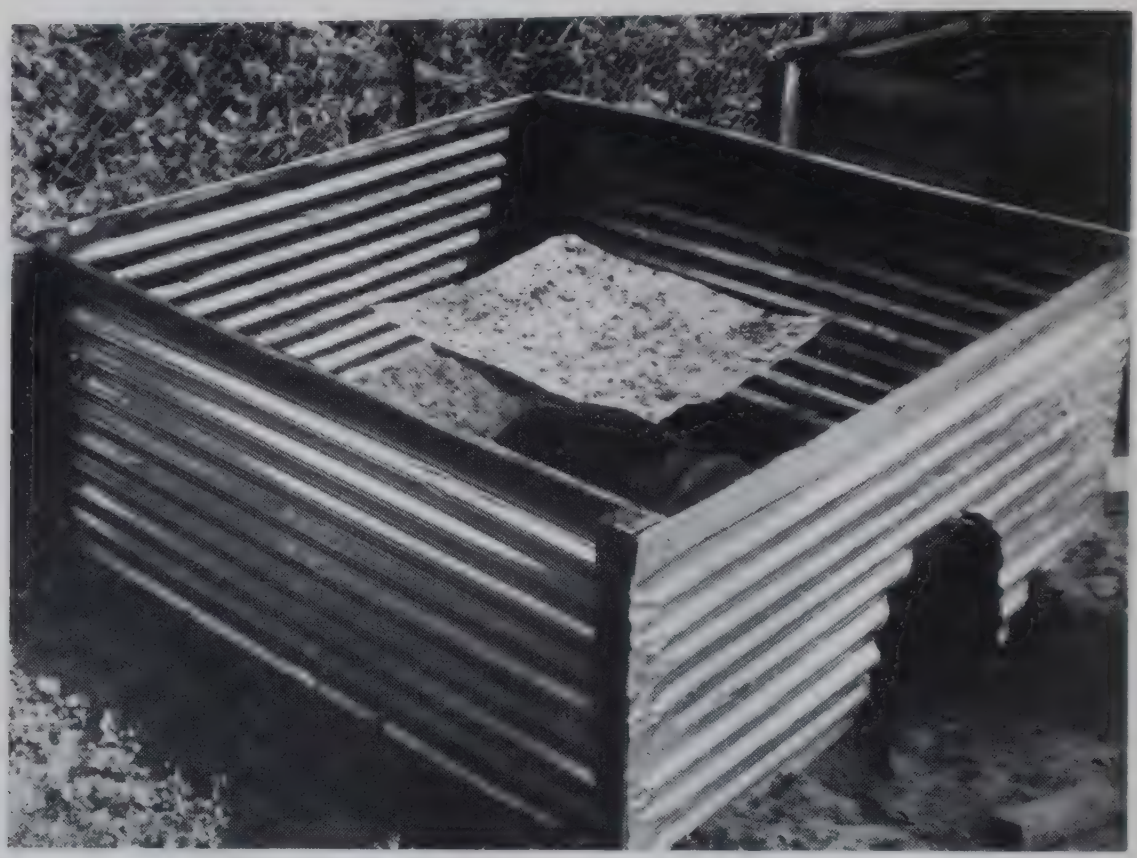


FIGURE 30. – *Modified version of the Altona-type oven.*

material. The framework of the ovens can be made, for example, of wood and the sides of corrugated iron; it is also possible to use oil drums, crates, mud walls, etc. The two extremities of the drums are removed. One end serves for fueling and provides the draught. At the other end of this drum is placed another half-drum, which has a hole of 1 ft 2 in (35 cm) in diameter cut out of the top. This hole permits the smoke to spread into the central part of the oven. In order to ensure uniform smoking, the smoke is dispersed by means of half a sheet of corrugated iron suspended by wire about 10 in (25 cm) above the opening in the half-barrel. This disperser is perforated about every $2^{2}/_{5}$ in (6 cm) with holes $^{1}/_{2}$ in (2 cm) in diameter. The fish is placed on grills fixed to wooden frames. These frames enable several layers to be placed on top of one another without the fish touching, thereby assisting drying.

The modified type of traditional oven was found to have certain advantages. The operations required were similar to those of the

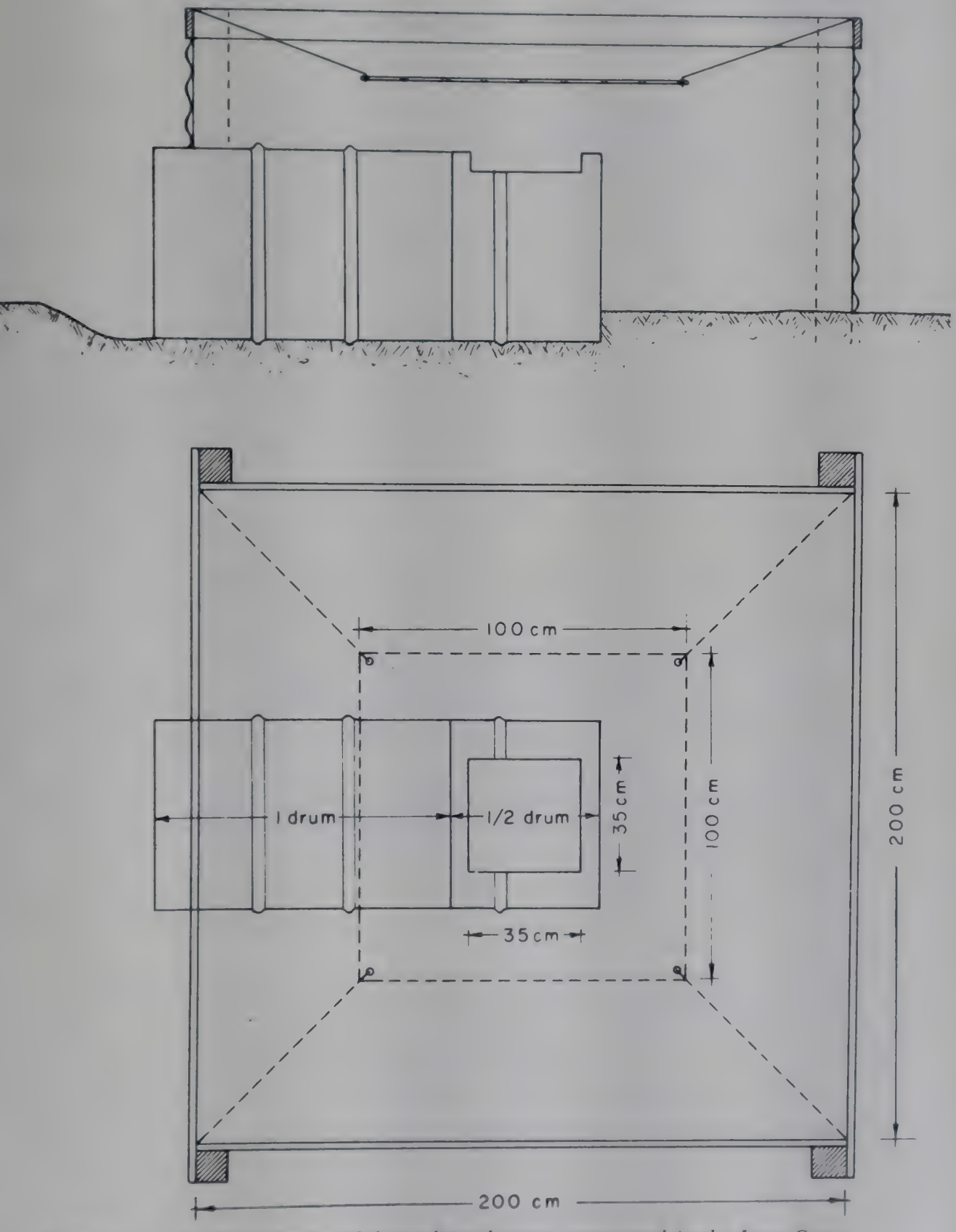


FIGURE 31. – *Modified version of the traditional square oven tested in the Ivory Coast.*

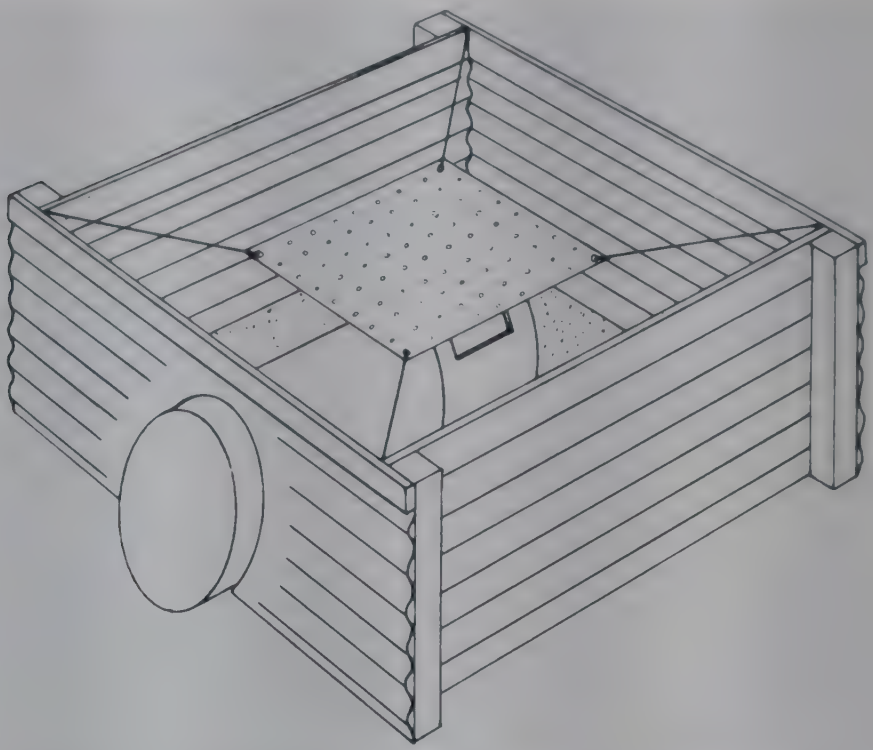


FIGURE 31 (CONTINUED). – *Completed modified Altona-type oven.*

traditional oven, costs for fuel were low, no special equipment was required, and the smoking of the fish was uniform. On the other hand, the Altona oven was found suitable for larger quantities of fish.

Further details of the study referred to can be found in the FAO EPTA Report No. 2032 (1965) *La conservation du poisson.*

OTHER METHODS OF FISH PRESERVATION

Methods of preservation other than those described in this manual are used to some extent in West Africa, but are not yet practicable on a large scale, primarily for economic reasons. It is nevertheless important that they should receive mention here within the general context of fish preservation, and they will undoubtedly become more important in the future.

Icing and freezing of fish

Fish can be simply preserved by icing, but initial capital costs for plant construction and purchasing power of the consumer limit the wide application of this method in Africa. Catches must be sufficiently large to justify the cost of providing ice supplies and there must also be a market for iced fresh fish.

The use of ice is subject to the following simple rules:

1. The ice and fish must be kept in an insulated container so that the temperature inside is maintained as near to freezing point (32°F, 0°C) as possible.
2. To ensure that the fish when caught is brought to freezing point and maintained there, plenty of ice should be used, at least as much ice by weight as fish. Insufficient ice is almost as bad as none at all and its cost is wasted.
3. If the fish is to be kept for long periods (2 - 3 days), extra ice must be added from time to time.

A simple container can be made for use in small canoes by lining a beer crate on the outside with sheets of insulating material and covering this with plywood. In this way an icebox can be made for a small outlay, which will keep the ice in good condition for several hours.

When caught, the fish should be gutted and its gills removed. The gills are best removed by a pair of pliers as they are bony. The guts (viscera) are removed by slitting open the stomach, exposing the insides and cutting them out by a transverse cut behind the head. After a thorough wash in sea water the fish is placed in the ice box.

A layer of ice is placed in the bottom of the box and the fish placed on it. Pieces of ice should be put in the body cavity and below the gill cover. The

fish is then covered with further layers of ice and fish until the box is full. The last layer must be ice. This will ensure that the fish is reduced to freezing point as quickly as possible.

Sufficient ice will reduce the temperature and hold it down until the fish is either sold or put through a further process of preservation.

In the tropics well-iced fish can last for several days, and can even reach distant inland markets in a fresh condition. This means of preservation is simple in application and effective.

It should be emphasized that:

1. The ice must be applied when the fish is fresh - as soon after catching as possible.
2. Sufficient ice must be used and it must be isolated from surrounding heat by insulating material. No insulation will compensate for using too little ice.

Further considerations in relation to the use of ice are:

(*a*) A fisherman must have a large enough catch to warrant the use of ice - that is, to ensure that the additional cost will pay for itself.

(*b*) Ice should be readily available in sufficient quantities.

Simple flake-ice machines are on sale which can be installed in fishing boats, or on shore where electric power is available.

Experiment with icing

The following experiment was carried out by the author in West Africa to demonstrate the effectiveness of using ice.

Line fishing 50 miles off shore for snapper and red bream.

Air temperature between 75°F (24°C) and 85°F (28°C) with very high humidity (optimum conditions for fish spoilage).

The fish were divided into four lots.

1. Whole fish exposed to the surrounding atmosphere.
2. Whole fish with gills and guts removed, thoroughly washed and exposed to surrounding atmosphere.
3. Whole fish on ice.
4. Whole fish on ice, gutted, gilled and thoroughly washed, prior to being iced.

The results at the end of 48 hours were:

Lot 1. Fish putrid and smelling badly. Flesh soft, smelling, eyes sunken, opaque and the gills covered in slime; stomach distended.

Lot 2. This was not much better than the first but it had kept in good condition for the first 24 hours. At the rate which bacteria multiply this was to be expected.

Lots 3 and 4. For these the condition of the fish was excellent and quite as good as that of freshly caught fish.

Freezing

Bacterial action is slowed down but not stopped by ice. If it continues the fish will become unfit for consumption in two to three weeks. If storage for longer periods is required they must be frozen. Frozen fish will keep for many months.

The establishment of freezing plants is an expensive undertaking. The scale of operations and the market for the frozen products must justify the capital investment. The plants can supply fresh-frozen fish either for immediate distribution or for subsequent re-processing by smoking, canning or the production of fish meal. Freezing plants can also supply ice to boats requiring it and the best situation for them, therefore, is in a harbor where fishing boats can tie up alongside.

There are various types of freezing plant and a full description of them would be outside the scope of this manual.

Fish protein-concentrate[1]

Production of fish protein-concentrate originally arose as a by-product of canning in the utilization of certain waste materials. The canning process produces quantities of oil and meal, which, depending on the species of fish and the state of the material, may be utilized in several ways. The oil is used for the paint industry and the meal, depending on the quality, is used for human consumption or for animal feed or fertilizers. In recent years the value of fish protein-concentrate (variously referred to as fish meal or fish flour) as a supplement to diets which are deficient in protein has been recognized. The production of fish protein-concentrate from fresh fish under extremely hygienic conditions is a process which has met with success and should be encouraged in the interest of better nutrition, especially in developing countries.

In this process whole fish are used and — apart from washing — no further handling is required, provided the fish are perfectly fresh. When the process is complete, the meal has lost very little of its original composition, apart from water, and the taste is close to that of the original product and is eaten in a way similar to smoked fish. The normal method of eating well-dried

[1] Fish meal or fish powder for human consumption.

and smoked fish is to break it up and add it to soups. In the form of fish protein-concentrate it is most convenient to mix with other foods.

Fish protein-concentrate will keep for a year or more without any marked deterioration in either quality or nutritive value.

Production of fish protein-concentrate

The basis of fish protein-concentrate is the extraction of water and oil from the fish. Oil has nutritive value and some of it should be retained in meal which is to be used for human consumption.

Two processes are in general use — the dry method of reduction and the wet-reduction process.

The dry method is used mainly for fish with a low fat content, such as the shark, snapper, bream and threadfin species.

The wet method is used mainly for fatty fish, such as sardines, pilchards, herrings and mackerel. These constitute the majority of the fish used for producing fish protein-concentrate.

The wet-reduction process differs mainly from the dry method in that the fish are cooked. This breaks up the fat cells, permitting the oil to be easily extracted when pressure is applied at the next stage. As oily fish tend to spoil rapidly in tropical temperatures, the sooner the fish is cooked the better.

Production of fish protein-concentrate in Ghana

In Ghana a process for producing fish protein-concentrate on a pilot scale was developed by F.R. Johnson with *Sardinella* in the early nineteen fifties. The *Sardinella* season in Ghana lasts from July to September and although large quantities of this valuable food are caught, there is a limit to the number which can be eaten fresh at the time. *Sardinella* has a good flavor and is highly nutritious.

Some fish protein-concentrates are produced in which the color, taste and odor are deliberately removed by various processes, but in this case efforts were made to preserve as much of the original flavor as possible.

As the meal produced is for human consumption, very high standards of cleanliness have to be observed and only fresh fish can be used in the process. *Sardinella* has a fat content ranging from 2 - 7 percent by weight of the whole fish. The lower figure applies to the beginning of the season, rising to the higher figure in September. So long as the fat content does not cause the meal to go rancid or make it sticky and difficult to grind, a reasonable amount is not a disadvantage. Some of the fat, however, must be extracted and the method used by Johnson was pressure cooking followed by pressing in a simple palm-oil press — a physical and not a chemical extraction. An outline of the process is as follows:

1. The fresh fish, complete with bones, is washed clean and cooked in a pressure retort for 15 minutes at 234°F (130°C). 15-lb pressure is applied. This

was found to be the best temperature; lower temperatures do not soften the bones and scales sufficiently. (The whole fish is used but it is desirable to soften all the hard parts so that they can be easily ground: they add to the value of the food.)

2. The cooked fish is now compressed in a palm-oil screw press to remove about half the water and fat. The residual cake still retains about 50 - 55 percent of its water and a little fat.

There are now two distinct products, the pressed fish and the liquid extraction, both of which must be further processed. The liquid contains a number of mineral salts which are important to the quality of fish protein-concentrate. This liquid is subjected to evaporation and added subsequently to the pressed fish, thereby retaining its flavor, and the whole mixture is dried in a "Farramatic" concentrator with steam at 234°F (130°C) and 25-lb pressure in a jacket.

The process lasts approximately three hours and results in a reduction of water content to the level of 5 - 9 percent. Reduction of moisture content to below 40 percent reduces bacterial activity and the meal is dry enough to remain in good condition for a long time. Finally, the "cake" is put through a mill to produce a fine powder.

Fish protein-concentrate does not become strong-smelling because of the removal of the fat. Fats, when exposed to high temperatures and humidity, tend to oxidize, producing a rancid condition. However, the fish protein-concentrate produced by Johnson had no such tendency and analysis by FAO in Rome showed that the oil contained its own antioxidants.

The meal has proved highly acceptable in areas of northern Ghana where inexpensive and palatable sources of protein are very scarce. It will keep for a number of years in difficult weather conditions where temperatures average over 75°F (42°C) and humidity is in excess of 80 percent.

Small-scale production of fish protein-concentrate

The Ghana plant described above produced good results but was comparatively costly and needed a steam boiler and electricity for its operation. It was not practicable for use in small fishing villages. The author devised a simpler process using materials readily available in West Africa, which is described below. It is based on the following stages:

1. Cooking the fish.
2. Separation of press cake and press liquor by the pressure method.
3. Concentration of the press cake.
4. Concentration of the press liquor.

A 44-gallon oil drum, of a type readily found in West Africa, is the main requirement in addition to a screw palm-oil press. The equipment is simple to make, is manually operated and requires only wood for fuel.

Cooking the fish. A 44-gallon drum is cut in half length-wise with a hacksaw or hammer and cold chisel. Sufficient water to cover the fish is placed in the drum and boiled over the fire. The cooking should be carried on for sufficient time to break down the oil cells. The time will depend on the quantity of fish in the cooker but should not exceed 45 minutes. Care must be taken that the water does not boil away.

After cooking, the excess liquid is poured off and the solid materials remaining are placed in the screw press. (A simple press can be made by using a packing case with a lid which just fits and is forced down by heavy stones, but this is naturally not as efficient as the screw press.)

Up to 40 percent of the water content may be extracted in this manner and final drying can be done in the sun or by the use of a simple drum heater over the fire.

In the experiment being described, a second 44-gallon drum was used. This was fitted with one axle through the center and another axle resting on stands over a fire. The press cake was placed inside and the drum rotated from time to time to agitate the meal.

When using a simple container of this kind, care should be taken that it does not cause overheating of the drum by direct contact. Parts of the press cake tend to stick together and have to be agitated frequently by a metal poker with a flattened end. (This can be improved by fitting paddlers to the axle so that the agitation and prevention of scale is automatic when the drum is rotated.) Four small holes are punched at the side of the drum to allow moisture to escape.

Pressing. After cooking separation by mechanical means is made using the press. This squeezes out a mixture of water, oil and certain salts: the whole is known as press liquor. The material remaining is known as press cake. The fish protein-concentrate consists of the solids, the remainder of the water to be extracted and some oil.

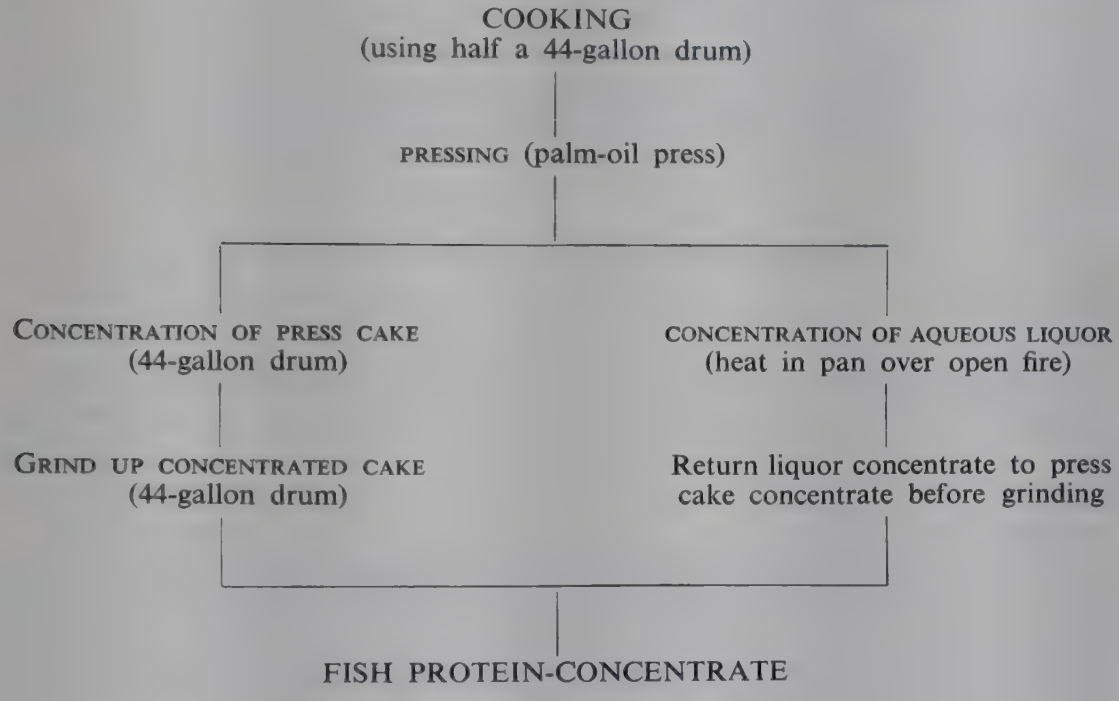
Large plants employ various types of cookers and presses which involve a comparatively high cost. In a small plant manually operated screw presses are quite suitable and in West Africa palm-oil presses are readily available.

The two different extracts are now dealt with as follows. The press cake is placed in a concentrator similar to that used with the drying process. The press liquor is placed in settling tanks. As its main constituents are oil and water, separation is not difficult; the oil will float to the top and can be removed. If a centrifuge is available this will speed up the operation and will also provide purer oil. This oil can be used for cooking purposes or, if available in sufficient quantities, can be supplied to paint factories. Reduction of the aqueous part of the press liquor is carried out by simply using a cooking pan and simmering over a fire until the liquid is sufficiently concentrated to be returned to the press cake.

Crushing the meal to a powder is not difficult. In this particular experiment it was done in a commercial corn mill but could have been carried out in other

ways. For example, stones in a container may be used, agitating them until they pulverize the cake to a fine powder. A 44-gallon drum may again be used, or even a biscuit tin.

The following diagram summarizes the process described. The principles are the same whether it is on a commercial scale or on the domestic scale outlined below.



The merits of fish protein-concentrate

There is no doubt that fish protein-concentrate is a most valuable means of preservation (especially for communities with little purchasing power) for the following reasons.

1. Fish protein-concentrate plant reduces whole fish. All that is removed is some, if not all, of the water and a little fat. The latter course is desirable as the meal would be over-fat in the case of oily fish.
2. It is easily stored and *Sardinella* in West Africa contains antioxidants so that the fat does not become rancid after long storage.
3. Being in powder form, very small quantities can be measured out and sold. This factor is most important where the purchasing power of the consumer may be very low. Whole fresh or smoked fish are often beyond the reach of the poorer people.
4. Flavor is maintained and in fact rather improved, since it is more concentrated and more noticeable in fish soups.
5. The process can be either on a large scale or simply a cottage industry in a village. The former depends on very large catches which justify the

expense, but the latter requires very little capital. The main thing is to observe certain rules of hygiene. They are:

(*a*) use completely fresh material,

(*b*) clean all equipment thoroughly before and after use,

(*c*) take precautions to see that no scorching occurs during the concentration of the press cake.

If these rules are kept and care is taken, a product as nutritious as smoke-dried fish is obtained, and with much better keeping qualities. It can be cheap to produce and even in a commercial plant requires a minimum of unskilled labor to operate.

Fish canning

Canning involves the use of considerable heat and equipment, so that it cannot be readily used unless adequate funds and supplies of power are available. The process is one in which the food is sterilized in cans by heat and then sealed from the surrounding air to prevent further attacks by bacteria.

Certain types of fish are not suitable for canning. When fish is sterilized and then given a final heating it is cooked. White-fleshed and less oily fish tend to break down with cooking and do not lend themselves to canning. The demersal fish fall into this category. Fish with a high fat content have much firmer flesh and can withstand the heat. Herring, mackerel and tuna are suitable for canning but many white fish are not.

Canned fish is very popular with consumers and large quantities are imported into West African territories. If production of fish yields cheap supplies of fish suitable for canning over a long period and in sufficient quantity, the establishment of local canneries is justified. Funds for initial equipment and skilled staff to work the plant are required, and there must be cheap, regular supplies of fish to ensure a low-priced canned product. If these conditions are not satisfied a cannery will either fail or require a subsidy and will lie idle at times.

Trained staff cannot be employed on a part-time basis and be expected to find alternative employment when canning is not in progress. On the other hand, paying to retain them during the unproductive season is not economical and if they leave they are lost to the industry.

One of the basic problems of fish canning is to ensure the quality of the raw material delivered to the cannery. Really fresh fish requires speed in catching, efficient fast boats and good handling. Fish caught in drift nets have to be shaken out, as they are caught by the gills, a process which may take several hours. Fish caught by purse-seining nets, on the other hand, are usually encircled and landed in less than one hour. The fish must be landed as quickly as possible and iced before any spoilage can set in. Herring, for example,

cannot be kept long even on ice, particularly in tropical conditions, and the quicker the boat reaches port the better.

Mechanization of boats is, therefore, a great advantage, particularly where catches are being canned.

It may happen that catches are too plentiful for a cannery to handle them, so that if a cold store is available, the surplus may be frozen. Subsequently, when the cannery is able to deal with the surplus, it can be unfrozen. A cold store has the added effect of prolonging the catching/canning period.

There are four important criteria in relation to raw material for canning:

1. Use of the correct type of catching gear, involving little delay between catching and storage on board.
2. Use of ice to chill the fish.
3. Use of mechanization to ensure maximum speed to market. Power is also necessary for the use of purse-seining nets.
4. Availability of a cold store as a buffer against gluts of fish, and to permit the continuation of canning when catches are small. A cold store is less important when regular supplies of raw materials are available throughout the year.

It is important for the cannery to be close to the landing or cold store. It would be pointless to have a cannery any distance from the point of landing, because transport costs increase production expenses and the raw materials suffer deterioration.

A summary of the essential conditions for economic preservation by canning — apart from supplies of skilled labor to operate the cannery — is given below:

1. Suitable types of fish, such as tuna, herring (*Sardinella*), anchovy, mackerel, and some of the horse mackerels.
2. Availability of these fish in large, fairly regular supplies throughout the year.
3. Cheap electric or other power to work the machinery and good supplies of water.
4. Supplies of skilled labor to maintain and operate the cannery.

Canning is an expensive process and at present is suitable only where it is possible to develop an export trade. The enterprise may then be able to produce a cheaper product for use locally.

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In addition, the Department of Fisheries of FAO, Rome, can supply various pamphlets and booklets on fish catching and preservation.

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